UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Southwest Region
501 West Ocean Boulevard, Suite 4200
Long Beach, California 90802-4213

SEP 27 2001

In Reply Refer To:
SWR-99-SA-46:SW

Michael J. Conrad, Jr.
Colonel, District Engineer
U.S. Army Engineer District, Sacramento
Corps of Engineers
1325 J Street
Sacramento, California 95814-2922

Dear Colonel Conrad:

Enclosed is the biological opinion which analyzes impacts to the endangered Sacramento River winter-run chinook salmon (*Oncorhynchus tshawytscha*), threatened Central Valley steelhead (*O. mykiss*), and threatened Central Valley spring-run chinook salmon (*O. tshawytscha*), and designated critical habitat, from Sacramento River Bank Protection Project (SRBPP) Contracts 42E and 42F, in accordance with section 7 of the Endangered Species Act of 1973, as amended (16 U.S.C.1531 et seq.). Based on the best available scientific information, the National Marine Fisheries Service (NMFS) concludes that Contract 42E and 42F actions are not likely to jeopardize the continued existence of the listed chinook salmon ESUs or steelhead ESU, or result in adverse modification of designated critical habitat, due to the incorporation of off-site setback levees and/or other proven conservation measures into the suite of project actions.

Because this opinion has found that the project is not likely to jeopardize the existence of the listed species, an incidental take statement with reasonable and prudent measures designed to minimize incidental take has been prepared. The incidental take statement authorizes the incidental take of winter-run chinook salmon, steelhead and spring-run chinook salmon during the course of construction of the experimental design at RM 149.0 (Contract 42E). The remaining (Contract 42F) bank protection sites (RMs 85.6, 123.5, 130.0, 130.8, and 164.0) will require future site-specific consultation before obtaining incidental take coverage for Sacramento River winter-run chinook salmon, Central Valley steelhead, and Central Valley spring-run chinook salmon.

Consultation must be reinitiated if (1) the amount or extent of taking specified in the incidental take statement is exceeded; (2) new information reveals that the SRBPP proposed experimental design (action) at RM 149.0 may affect winter-run chinook salmon, steelhead or spring-run chinook salmon, or their designated critical habitat in a manner or to an extent not previously considered; (3) the action is subsequently modified in a manner that causes an effect to the listed species that was not considered in the biological opinion; or (4) a new species is listed, or critical habitat is designated that may be affected by the action (50 CFR § 402.16).

In response to the Corps' July 10, 2001, letter to NMFS, requesting Essential Fish Habitat (EFH) consultation for SRBPP Contracts 42E and 42F, this document also transmits EFH Conservation Recommendations for Pacific Coast salmon which may be effected by the proposed action as required by the Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA) as amended (16 U.S.C.1801 et seq.).

If you have questions concerning the enclosed biological opinion, please contact Ms. Shirley Witalis at (916) 930-3606.

Sincerely,

Rodney R McInnis

for Rebecca Lent, Ph.D.
Regional Administrator

Enclosure

cc: Mr. Wayne White,
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<u>Endangered Species Act - Section 7 Consultation</u>

BIOLOGICAL OPINION

Agency: United States Army Corps of Engineers, Sacramento District

Activities: Sacramento River Bank Protection Project, Contract 42E, Proposed Levee Reconstruction at River Mile 149.0, Colusa County, California, and at Five Other Sites Along the Mainstem Sacramento River

Consultation Conducted By: National Marine Fisheries Service, Southwest Region

Date Issued: SEP 27 2001

This document represents the National Marine Fisheries Service's (NMFS) biological opinion (Opinion) based on our review of information provided by the United States Army Corps of Engineers (Corps) and the Reclamation Board of the State of California (Reclamation Board) for the proposed Sacramento River Bank Protection Project Contract 42E Proposed Levee Reconstruction at River Mile 149.0; and for proposed Sacramento River Bank Protection Project Contract 42F, consisting of five other embankment sites along the Sacramento River, in accordance with section 7 of the Endangered Species Act of 1973, as amended (6 U.S.C. 1531 et sq.) (Act).

I. CONSULTATION HISTORY

On December 1, 1999 NMFS received a letter from the Corps and the Reclamation Board requesting a formal Section 7 consultation on six sites designated under the Sacramento River Bank Protection Project (SRBPP), Contract 42E. Among the correspondence was an Information Sheet on Initiation of Formal Consultation. At this time, the contract had been reduced to six proposed work sites, however, the Corps requested that NMFS provide multiple opinions considering two alternatives at certain sites. NMFS responded by correspondence, dated January 5, 2000, stating that the initiation package was incomplete and consultation could not proceed. NMFS requested (1) a firm description of the projects to be constructed; (2) a more detailed analysis of cumulative effects focusing quantitatively on the amount of and effects from revetted banks on the survival of juvenile and adult listed salmon; and (3) information to address concerns regarding (a) the equivalency of Habitat Suitability Index (HSI) values of proposed mitigation features with those of existing shaded riverine aquatic (SRA) cover; (b) the adequacy of proposed mitigation features in providing ecosystem functions and values for juvenile salmon survival, and (c) the adequacy of the compensation analysis (habitat gains/losses between sites) in taking into account minimum distances associated with habitat refugia.

On February 4, 2000, NMFS received the draft supplemental HEP Analysis, Contract 42E, prepared by Jones and Stokes Associates. This draft addressed changes to the bank protection designs and the changes discussed by the HEP team concerning HEP data, assumptions, and the results.

On April 12, 2000, the Corps, Sacramento District, requested section 7 consultation regarding the potential effects of the proposed implementation of streambank protection at River Mile 149.0 on Federally endangered Sacramento River winter-run chinook salmon, threatened Central Valley spring-run chinook salmon, and threatened Central Valley steelhead or their designated critical habitat. The scope of the request had been reduced to one proposed work site where, according to the Corps, there was an urgent need for levee repairs before the coming rainy season.

On April 25, 2000, NMFS received a letter from the Corps containing a comment-by-comment response to the specific concerns addressed in NMFS' January 5, 2000 letter. Included in the correspondence package was a request for formal Section 7 consultation on site RM 149.0 as a high priority site; the Corps requested that consultation on the remaining five SRBPP, Contract 42E sites be temporarily postponed until later in the year.

On May 4, 2000, NMFS received a copy of the Final Biological Data Report Sacramento River Bank Protection Project Site River Mile 149.0, dated March 24, 2000, prepared by Jones and Stokes for the Corps, Sacramento District.

On May 10, 2000, U.S. Fish and Wildlife Service (USFWS) and NMFS conferred on priority goals for upcoming Environmental Statement consultation for RM 149.0 site, SRBPP Contract 42E. Special conditions agreed upon were compliance to a monitoring program of an appropriate time length, and a finalization on the specific design of the rock/log structures for the levee.

On June 20, 2000, NMFS received the draft Environmental Assessment and Site-Specific Review (EA/SSR) for streambank protection work proposed on the Sacramento River under the authority of the Sacramento River Bank Protection Project, an updated design plan for site RM 149.0, and the Draft Final of Invitation for Bids, May 12, 2000, Sacramento River Bank Protection Project Sacramento River and Tributaries, California Bank Protection - Contract 42E of Separable Element 42, hand-delivered to the NMFS office.

On June 21, 2000, a meeting was held between the Corps, the Reclamation Board, Ayres Associates (Ayres), USFWS and NMFS to address specific design concerns for Site RM 149.0L. Jason McConahy of Ayres provided an overview of the current RM 149.0 draft design plans and parameters, and a discussion on those details followed, involving all present parties. The agenda included a discussion on potential action at Site RM 125.8 (aka RD 70 "Grimes site"); mitigation needs and options for the remaining five contract 42E sites, lead by Ken Casaday from Jones & Stokes, and on the next steps to be taken concerning consultation on those sites, lead by Creg Hucks from the Corps.

On June 22, 2000, an e-mail message from Richard DeHaven, USFWS, clarified the specific changes requested in the Contract 42E, RM 149.0 as discussed in the previous meeting. These details concerned instream woody material, tree height, diameter, number and orientation; revised description of the rock clusters; root-ball removal, and redesign and placement of the concrete tree anchor.

On June 22, 2000, Jason McConahy of Ayres provided pixtel images of current flow pattern of RM 149.0 and existing conditions of velocity distribution, as per request of NMFS and USFWS.

On June 23, 2000, NMFS received the draft Environmental Assessment and Site-Specific Review (EA/SSR) for streambank protection work proposed on the Sacramento River under the authority of the Sacramento River Bank Protection Project, dated June 9, 2000.

On June 29, 2000, Ayres' response to USFWS questions regarding site lengths was provided to NMFS by e-mail, and the component lengths in the project description of the EA were revised.

On July 24, 2000, NMFS received an e-mail copy of the correspondence from Jason McConahy, Ayres Associates, to USFWS, concerning the incorporation by the Corps of review comments for revision of the plans for RM 149. This included 2 detail schematics of the design including these modifications to the rock clusters and in-stream woody material.

On July 26, 2000, the Corps e-mailed to NMFS a copy of the final modifications pertaining to tree removal, tree placement, and concrete anchor blocks; and a detail schematic of the design.

On July 31, 2000, USFWS e-mailed to NMFS a copy of their responses to the July 24 review comments on the plans for RM 149.

NMFS confirmed to Matt Davis of the Corps by phone that all information was received to initiate consultation on RM 149.0 at the end of July, 2000.

On August 3, 2000, USFWS submitted a letter to the Corps indicating that the consultation will cover all 6 projects.

On August 8, 2000, NMFS received a copy of a report, dated August 3, 2000, from USFWS to the Corps, regarding the Scope of Work between the Service and NMFS on the proposed Contract 42E of the Sacramento River Bank Protection Project. Also included was a copy of the USFWS document *Impact of Riprapping to Ecosystem Functioning, Lower Sacramento River, California*, published in June 2000.

On February 15, 2001, NMFS' draft biological opinion was submitted to the Corps. This opinion found that the SRBPP's proposed action would jeopardize the Sacramento River winter-run chinook salmon, the Central Valley steelhead, and Central spring-run chinook salmon, and would adversely affect their designated critical habitat. As directed by 50 CFR §402.02, NMFS developed reasonable and prudent alternatives (RPAs) within the February 15, 2001 biological opinion to avert the likelihood of jeopardy.

The four RPAs appearing in the February 15, 2001 draft jeopardy biological opinion were refined during subsequent negotiation into a single RPA.

On March 15 and March 23, 2001, NMFS, USFWS, the Corps, the Reclamation Board, and Jones and Stokes Associates staff met to discuss the RPAs, revisions to the project description, and alternate conservation measures.

On June 12, 2001, management staff of NMFS, USFWS, the Corps, and the Reclamation Board met to discuss specific issues related to the implementation of the preferred RPA 2, as proposed by USFWS on May 29, 2001.

On June 20, 2001, NMFS, USFWS, the Corps, and Reclamation Board staff met to discuss specific issues regarding the issuance of a revised draft jeopardy biological opinion. The agreements made between the Corps and NMFS and USFWS, including refinements generated during subsequent discussions with Corps and Reclamation Board staff, have been incorporated herein.

On July 11, 2001, NMFS, USFWS, the Corps, and Reclamation Board staff met specifically to discuss justification for the 5:1 ratio on mitigation replacement for adverse impacts to designated critical habitat. The meeting adjourned without consensus on the ratio.

On July 23, 2001, NMFS, USFWS, the Corps, and the Reclamation Board met for a final time to come to terms on the 5:1 replacement ratio, and to discuss the differences and implications of the two regulatory agencies' biological opinions. The meeting ended with agreement by all parties to a 5:1 mitigation ratio for site RM 149.0, and incorporation of the final RPA into the project description. The agreements made between the Corps and NMFS and USFWS have been incorporated herein.

On July 27, 2001, the Corps formally accepted the revised Reasonable and Prudent Alternative (RPA) as a revised section to their project description. NMFS was notified with a faxed copy of the unsigned letter sent to USFWS, and accordingly edited the SRBPP Contracts 42 E&F biological opinion to include the new project description.

On August 2, 2001, a verbal request was made by the Corps to NMFS for its' revised RPA. NMFS accommodated this request on August 3, 2001, and received the Corps' draft version on August 6, 2001. NMFS re-edited the RPA, and transmitted it back to the Corps on August 7, 2001; this most recent version has been incorporated into the biological opinion's project description.

On August 9, 2001, NMFS received the Corps' letter sent to the NMFS Regional Administrator, dated August 7, 2001, detailing the revised project description.

II. DESCRIPTION OF THE PROPOSED ACTION

The Corps of Engineers proposes to implement flood-protection projects at six designated levee sites along the Sacramento River, within Phase II of its Sacramento River Bank Protection Project program. Phase I of the SRBPP, conducted from 1960 to 1975, resulted in the riprapping of approximately 430,000 lf (81.4 miles) of river bank. Phase II was authorized by the River Basin Monetary Authorization Act of 1974 (Public Law 93-251), which funded an additional 405,000 lf of bank protection following the completion of Phase I of the SRBPP. The following is a description of the sites as they currently are, and of the proposed actions of each project.

Contract 42E Action. Erosion has encroached into the left bank (downstream aspect) levee of an outside meander bend in the vicinity of RM 149.0 of the Sacramento River, about 5 miles upstream of Colusa, Colusa County, California. The levee at this site is wholly composed of earthen substrate which has not previously been riprapped. The Corps and Reclamation Board are proposing to alleviate risk of levee failure and flooding by reconstructing the river bank and levee along the site, and riprapping the reconstructed area with quarry rock.

The proposed action would result in about 675 linear feet of riprap. About 295 feet of this, in roughly the middle portion of the site where the critical erosion zone exists, would involve "bank fill" construction. Here, the bank would be restored to a uniform 2.5:1 grade. Riprap would extend from the levee toe upslope to the existing berm, which averages about 16-20 feet vertically above the mean summer waterline (MSW). Riprap would be about 1.3 feet thick, except at the levee toe, where a toe trench about 3.3 feet deep and 6 feet wide at the bottom would be built and filled with rock.

Another 175 feet of the downstream end of the site would undergo "bank cut" construction, which would remove a point which projects into the river just downstream of the critical erosion area. This section of reconstructed levee would then also be riprapped, just as in the "bank fill" construction area. This riprap would be tied in on its downstream end to existing SRBPP riprap consisting of river cobble rock. The berm in this area of the site averages about 20 feet above the MSW.

Another 205 feet of the upstream end of the site would also be riprapped, but in a different manner than the downstream 470 feet. This upstream riprap, called "toe rock", would extend from the levee toe upslope to only the mean summer waterline (MSW). Toe rock would be placed directly on the bottom, without excavating a toe trench or employing any direct bank cut construction. However, in achieving a uniform levee alignment and surface, a thicker layer of rock - roughly 2-7 feet deep - would be used than in the two downstream portions of the site. Although bank cut construction would not occur below the MSW, at least 100 feet (and probably more) of the 205 feet would undergo bank cut construction above the MSW in conjunction with construction of the final proposed feature at the site - the "launchable riprap."

The launchable riprap would be buried about 100 feet landward of the newly riprapped upstream shoreline, beginning about 100 feet downstream from the upstream end of the site, and extending downstream roughly parallel to the river for about 95 feet. Installing this feature would involve four steps: (1) all trees and other vegetation would be cleared from the area; (2) earthen substrate between the launchable riprap embankment slope and the existing shoreline would be removed and stockpiled, using heavy equipment; (3) the launchable rock surface, with a final appearance essentially the same as a riprapped levee (and including the same rocked toe trench), would be built, facing the river; and (4) the stockpiled embankment material would then be replaced and the launchable riprap surface would be buried, restoring general alignment of the original bank, except above the MSW where the bank would be uniformly graded and shaped.

Description of the Proposed Conservation Measures

The indications made below regarding consultation on Contract 42F and Phase II actions in a site specific manner, refers to the need for the Corps to propose a conservation measure adequate to remove those sites' individual and aggregate jeopardizing effects. It must also be noted that the Corps' agreement to adopt the RPA does not address effects at RMs 26.9, 43.1 and 43.3. These actions are, at this time, considered to be a portion of Phase II, and will be re-evaluated with new details and measures, upon future re-initiations of this consultation.

In recognition of the urgent need to restore the fluvial function of the river, and thereby restore the components of critical habitat necessary for survival and recovery of Sacramento River winter-run chinook salmon, Central Valley steelhead, and Central Valley spring-run chinook salmon, the Corps has revised the project description for Contracts 42E and 42F. This description is the result of formal consultation between NMFS, USFWS, and the Corps, and is based on NMFS' draft jeopardy opinion, staff level discussions, and actions required to remove jeopardizing effects of the implementation of the proposed Contract 42E action at RM 149.0:

1. The Corps will implement RM 149.0 as designed. The Corps will immediately convene an Interagency Working Group (IWG) to locate and design a set-back levee or other conservation measure that restores fluvial functions to locations, off-site from RM 149.0, which are currently impaired or lacking (for example, removal of riprap from a site with high erosion potential). The conservation measure will, in whole or part, be responsible for minimizing the adverse effects of Contract 42E to a non-jeopardizing level. Excess habitat restoration may be credited towards future actions based on evaluation by the IWG and acceptance by NMFS and USFWS.

   Proven conservation measures (measures) presently include set-back levees, removal of riprap from and restoration of lands that currently lack lateral channel migration potential, including inter-levee terraces and potentially-eroding cut-banks. The pattern and profile of the river at any potential site will determine which measure will be most effective in restoring function, but all sites must include a high potential for the resumption of natural, erosive forces and lateral channel migration. Priority will be given to sites where the restoration will restore the greatest degree of fluvial process.

The IWG shall be comprised of representatives from the Corps, State of California Reclamation Board (Reclamation Board), NMFS, USFWS, and State Department of Fish and Game (DFG), at a minimum, and will be chartered as soon as is practicable after initiation of construction at RM 149.0. Other technical experts will participate as needed. The initial tasks are likely to involve real estate and engineering investigations for off-site conservation measures, as well as investigations into techniques for quantifying effects, compensation, and mitigative measures for current and future SRBPP actions. Each agency's legal roles and responsibilities (that is, planning guidance, regulatory oversight, and others) will remain intact.

2. Following a separate, site-specific consultation, the Corps will implement the previously designed and evaluated set-back levee alternative at RM 85.6 or a revised setback alternative at RM 130.8 site instead of the currently proposed riprap alternatives. The design criteria for the setback levee will be engineeringly feasible and take into account the biological needs of Sacramento River winter-run chinook salmon, Central Valley steelhead, and Central Valley spring-run chinook salmon on a site-specific basis to restore the habitat for the species targeted based on an ecosystem approach. Also following a separate, site-specific consultation, the Corps will implement the remaining Contract 42F bank protection sites (RMs 123.5, 130.0, 164.0, and 85.6 or 130.8) as currently proposed, and as designs and environmental documentation are completed.

Though NMFS has rendered an opinion on the six sites that may be implemented in Contracts 42E and 42F, there remain certain site-specific issues that require analysis. It is also anticipated that the IWG's input will substantially influence final site and conservation measure design to offset the finding of jeopardy. Therefore, implementation of the setback levee at RM 85.6, the revised setback alternative at RM 130.8, and/or the remaining Contract 42F bank protection sites (RMs 123.5, 130.0, 164.0, and 85.6 or 130.8) will require site-specific consultation to receive incidental take coverage of Sacramento River winter-run chinook salmon, Central Valley steelhead, and Central Valley spring-run chinook salmon.

The riprap at RM 149.0 (Contract 42E) may precede the setback levee at RM 85.6, RM 130.8, or at an off-site location. The proposed riprap at Contract 42F sites [RMs 85.6 (if riprapped) 123.5, 130.0, 130.8 (if riprapped), and 164.0] may precede the construction of proven conservation measures following site-specific consultation where NMFS would grant incidental take for the construction of these. Temporal losses of habitat at the respective sites are subject to the initial and annually-increasing conservation ratios.

3. If a setback levee at RM 85.6 or 130.8 is infeasible due to realty or design constraints, and the infeasibility is demonstrated to NMFS, the proposed riprap at 85.6 and 130.8 may be implemented after the Corps has concluded formal consultation on the proposed actions in a site-specific manner.

4. The Corps shall implement an off-site setback levee or other fluvial function-restoring measure to offset Contract 42E's adverse effects at RM 149.0 as soon as practicable after the determination that a setback at RM 85.6 or 130.8 is infeasible. The setback levee or other measure shall create a flood plain or erodible area (as applicable) that is no less than five (5) times as large in areal extent as the bank that exists between the existing edge of water at the mean summer water elevation (MSW) and the existing projected levee section at MSW. This habitat loss is quantified as the total areal extent of without-project lateral migration potential that will be lost to each action throughout Contracts 42E and 42F. The IWG may develop a more accurate and representative method for calculating the magnitude of the adverse effect, and this method may be applied to this and future efforts based on NMFS' acceptance. The Corps accepts the 5:1 ratio to offset the adverse effects that would occur to listed fish species with the proposed riprap alternative at RM 149.0 at this time. Future ratios (that is, for Contract 42F or other SRBPP actions) may differ, based on evaluation and compensation techniques developed by the IWG and accepted by NMFS.

   Should the Corps construct a setback levee or other measure at a site with an existing, vegetated bench, shaded riverine aquatic (SRA) cover, large woody debris (LWD), and other habitat features, the IWG shall evaluate the relative degree of function that will be restored, and NMFS and USFWS will use that information to determine the credit (towards achieving the required conservation acreage) that will be granted for the existing habitat. The highest priority will be given to currently riprapped sites with high potential for resumption of SRA, and LWD input from near-water areas and with lesser values inland of the near-water habitat. The Corps will then request an amendment to this opinion or reinitiate consultaiton based on the IWG's recommendation. The Corps then assumes that NMFS will use that information to determine the credit (towards achieving the required conservation acreage) that will be granted for the existing habitat.

   Should the Corps fail to implement an off-site setback levee or other measure within 1 year of riprapping a site, we agree to increased conservation ratios to offset the additional temporal habitat loss. After 1 year's time has elapsed at each site, the setback levee or other measure will be implemented by the Corps to create a floodplain or erodible area that is no less than six (6) times as large in areal extent as the bank that was riprapped by the action. Should the Corps fail to implement an off-site setback levee or other measure 2 years after construction at each site, the conservation ratio will increase to seven to one (7:1) for that site. The ratio will increase incrementally in this fashion as temporal habitat losses accrue and until a setback levee or other measure is implemented. Note that the Corps recognizes that the failure to implement a setback levee or other measure constitutes a failure to remove the finding of jeopardy from the Contract 42E increment of the SRBPP.

The 5:1 initial conservation ratio and additional increases are assessed on a site-by-site basis in the order each site is implemented; that is, the ratio first applies when a given site is first subject to work below the ordinary high water zone and concludes when a setback levee or other measure is implemented. The Corps will track the multiple time lines and acreages associated with these site-by-site conservation ratios and report them to the IWG for use in site selection.

The setback levee or other measure's flood plain or erodible area will include features intended to provide benefits to Sacramento River winter-run chinook salmon, Central Valley steelhead, and Central Valley spring-run chinook salmon. To help insure that restoration work be located within close proximity to the corresponding site of adverse impact, setback levees or other measures and removal of riprap will be implemented within an approximate 50 miles radius of each project site in the mainstem of the lower Sacramento River. Potential mitigation sites lying outside a 50-mile radius from a project site may be considered, subject to review and approval by NMFS.

Site design will be limited by engineering and hydraulic constraints, but will incorporate at least one of the following features: (1) a periodically inundated herbaceous-vegetated flood plain including a mosaic of SRA cover, some degree of canopy, and structural diversity; (2) significant occurrence of LWD; or (3) active erosion of banks. To ensure necessary components for survival and recovery of listed salmonids, the setback levee(s) will incorporate an SRA-planted berm in its design and implementation.

5. Construction of the setback levee or other measures shall also result in the removal of at least as many linear feet of riprap from the newly-abandoned levee or bank as will have been placed, as applicable, as bank protection and launchable riprap, in Contracts 42E and 42F. Should an off-site setback levee or other measure be implemented in a currently non-riprapped site, or should the total riprap removed not equal that placed under contracts 42E and 42F, the Corps will remove riprap from another location or locations until the total amount of removal

has been met. Non-Federal riprap placed subsequent to the enaction of the Clean Water Act and without a Department of the Army 404 permit or associated mitigation may not be credited for the off-site rock removal, as it may constitute an abrogation of another regulatory responsibility.

The setback levee or other measure's engineered (expected, anticipated) project life must equal or exceed that of the longest design life within the suite of Contract 42E and 42F bank protection alternatives. The setback levee or other measure's project life may be determined by hydraulic modeling.

Implementation of the setback levee or other measure must incorporate avoidance, minimization, and conservation measures sufficient to offset the adverse effects on all listed species under NMFS, USFWS, and CDFG jurisdiction. These impacts can be addressed by the IWG or by Corps staff during informal consultation.

The setback levees or other measures and removal of riprap may be constructed at any suitable location within the mainstem of the lower Sacramento River (not tributary streams or distributary sloughs), within the action area as defined in this biological opinion. The setback levees or other measures and removal of riprap may occur, if consistent with Corps policy and all other regulatory considerations, on Federal and non-Federal levees and other sites.

6. Should the Corps pursue additional SRBPP sites beyond those currently identified in Contracts 42E and 42F, the Corps shall initiate formal, programmatic consultation under a new biological opinion. This subsequent, programmatic consultation will be in association with projects identified for Phase II of the SRBPP and addressed under a supplemental programmatic environmental impact statement for the SRBPP. By revising the project description, the Corps commits to pursuing no additional SRBPP actions absent programmatic consultation.

If and when the Corps elects to pursue additional actions under Phase II of the SRBPP, a request for programmatic consultation shall be made to NMFS. The programmatic consultation package shall include all information necessary to initiate formal consultation as outlined in the regulations governing interagency consultations (50 CFR §402.14), including geographic information system (GIS) data and an associated map documenting the location of and habitat associated with *all* project and non-project riprap within the action area.

GIS information is crucial for determining the environmental baseline for listed species as well as for the analysis of cumulative effects required by the National Environmental Policy Act (NEPA).

Implementation of this RPA relies upon the successful, post-construction implementation of conservation measures to mitigate the effect of Contract 42E at RM 149.0 and, once refined, the aggregated effects of implementing the proposed incremental actions at RMs 85.6, 123.5, 130.0, 130.8, 149.0, and 164.0. Incidental take exemptions are, however, granted only for the proposed Contract 42E action at RM 149.0. These measures must rely on *proven* measures (i.e. a setback levee or other comparable restoration of fluvial function and lateral channel migration, that would adequately offset the significant impacts to aquatic resources that would occur, downstream, and upstream of RM 149.0. As stated throughout this and other documents, NMFS considers the implementation of setback levees and restoration of meander function crucial to the conservation of the listed salmonids.

NMFS believes that these actions avoid violation of section 7(a)(2) by adequately avoiding, minimizing, and mitigating adverse effects to the Sacramento River winter-run chinook salmon, Central Valley steelhead, and Central Valley spring-run chinook salmon, and designated critical habitat or deferring implementation of future Contract 42F actions until their subsequent formal consultations, including finalization of project designs and conservation actions, is completed.

The remaining features of the proposed action at site RM 149.0 are those originally proposed by the Corps to minimize the adverse effects of implementing the incremental action at RM 149.0. These measures are experimental and were designed for mitigation of impacts to fish and wildlife and their habitats, as follows:

7. *Rock clusters* would be placed at five locations atop the finished riprap surface. Rock used for the clusters would have the same properties as the riprap. The clusters would be uniformly spaced about 90 feet apart, with the lowermost (downstream) cluster at least 82 feet upstream of the downstream site limits. Each cluster would be about 13 feet wide at its base and 5 feet in height above the finished riprap, giving more or less the appearance of a rock pyramid extending upslope from the levee toe to MSW. Rock clusters would presumably restore some hydraulic diversity along the finished riprap, provide cover for fish and other aquatic organisms, and help trap and retain large woody debris (LWD).

8. *Large woody debris* would be permanently anchored between adjacent rock clusters. LWD would be derived from 12-13 of the larger riparian trees which would have to be removed from the site during construction of the launchable riprap feature. These trees range from 10-47 inches in diameter and 30-65 feet in height. Each tree would be removed from the ground with a significant portion of its root ball intact. All branches, limbs, twigs, and leaves would also be retained to the maximum extent practicable. However, one side (below centerline) of the main stem of each tree, including root ball, would then be cleared from top to bottom. This would allow a flat alignment of each finished LWD piece against the finished riprap surface between rock clusters. Anchoring each LWD piece to the riprip would be accomplished using two 6.6 foot x 2.5 foot concrete

encasements, one placed around the main stem close to the root ball, and another on the main stem about 0.4 of the length (of tree) down from the top. Each finished LWD piece would be placed between the rock clusters, with a total of three LWD pieces within each rock cluster spacing. Each LWD piece would be wholly submerged, with its root ball roughly flush with the MSW, and the main stem extending downslope on the levee, with the tree's top positioned near the toe of the levee. Each LWD piece would be angled slightly downstream, at between 15 and 30 degrees from a perpendicular to the finished bank. The intended purposes of the anchored LWD pieces is to provide both hydraulic and habitat diversity, cover for fish and aquatic organisms, sediment and organic material trapping and storage, and additional roughness to help trap and retain river-transported LWD.

9. *Replanting of riparian trees* would be done to replace trees removed during the construction of both the launchable riprap feature and the new temporary road that would be necessary to provide access to the toe rock construction area. A total of 0.26 acre impacted at these two areas would be replanted with native tree and shrub species placed at 6-foot intervals. A total of 0.50 acre would be similarly replanted along the finished riprap slope (roughly MSW upslope to the berm) in both the bank fill and bank cut areas. A total of 0.14 acre would be similarly replanted along the berm (exclusive of the required 15-foot-wide clear zone) at and just downstream of the action site. Establishment of the woody riparian vegetation would involve planting of container-grown stock, irrigation, weeding, replanting if and where necessary, and otherwise maintaining the vegetation for 2 years. The intended purpose of the plantings would be to restore all of the lost values and functions associated with woody riparian vegetation, including offsetting the time delay to re-create mature vegetation where mature vegetation would be removed.

Contract 42F Actions. Contract 42E of SRBPP originally comprised nine proposed construction sites on the mainstem Sacramento River between RMs 26.9 and 164.0. Subsequently, the Corps dropped the three lowermost sites from present consideration, leaving six sites between RMs 85.6 and 164.0 in the contract. However, it became apparent that planning and scheduling processes would not permit the six remaining Contract 42E sites to be constructed beginning in the summer of 2000. The Corps then moved forward with an expedited final design and environmental review process for the most serious of the sites, the RM 149.0 site, for which the Corps requested the present biological opinion. At the same time, the Corps stated its intent to consult subsequently under section 7 of the Act for (1) the remaining five sites of Contract 42E and then later, (2) for the approximately 30,000 linear feet of SRBPP work that would still remain under existing authority when the six erosion sites of Contract 42E have been addressed. More recently, the Corps has placed the five remaining sites in Contract 42E into a new contract, Contract 42F. The remaining bank protection contained in Phase II of the SRBPP will be addressed in additional contracts. NMFS has recombined both contracts (42E & 42F) into one biological opinion to break the cycle of "fragmentation" of individual consultations which weakens analysis of each project on the impacts to listed fish and foregoes the analysis of cumulative effects of the entire suite of projects on the designated critical habitat.

In a March 2000 report, the Corps' engineering consultant described and evaluated three construction alternatives for each of the five sites and the RM 149.0 site. All alternatives, except for non-selected set-back levee alternatives at RM 149.0 and RM 85.6, involve various riprapping scenarios. Some of these scenarios include specific environmental measures to offset aquatic and terrestrial habitat impacts. A "selected alternative" has been identified for each site by the Corps' engineering and biological consultants; the Corps has deviated little from these alternatives. The Corps' alternative is evaluated herein for each of the five sites as they relate to the RM 149.0 site in elements of project design.

Site 1 is located between Fremont Weir and Knights Landing, Yolo County, on the right bank at RM 85.6. This site is in a relatively straight river reach, just downstream of a short, but sharp bend in the river. The site has been previously riprapped in 1940 and possibly later. The riprap remaining consists of mostly 6-14 inch cobble, which occurs in varying density and coverage along about 95 percent of the shoreline corresponding to the non-selected set-back levee alternative length. A few areas along the site, thus, have earthen substrate exposed to erosion, including a large scallop/pocket into the levee section, resulting in near-vertical banks. On average, the existing riprap extends about 14 feet up the levee slope above the MSW.

The currently selected alternative for the site is the "bank fill rock slope and toe protection" alternative, which would include a typical (see RM 149.0 action description) toe trench and replanting of woody riparian vegetation in disturbed areas and along the finished quarry rocked bank. The riprap would be extended another 4 to 8 feet farther up the levee slope than present riprap, and the presently barren areas where the 1940 cobble riprap has eroded away would be reshaped and recovered with the new rock. The refinished length of the site would be 1,050 feet.

Site 2 is located between Tisdale Weir and the town of Grimes, Colusa County, on the left bank of the river at RM 123.5. This is a straight river reach just upstream of a sharp bend. This site has also previously been riprapped (unknown date[s]). Remaining riprap is composed of both boulders (>24-inch) and quarry rock (10-12-inch) along about 96 percent of the site length, and the rock covering extends an average of 22 feet upslope above MSW. The site has a single erosion pocket in the bank slope.

The currently selected alternative for the site is the "bank fill rock slope" approach, which would include a typical (see RM 149.0 action description) toe trench, toe rock, and replanting of the finished riprap with shrub vegetation. The 2.5:1 slope up to the elevation of the existing berm would repair the erosion pocket, shape the bankline, and restore the structural stability of the levee section. The new quarry rock riprap would extend another 5-10 feet farther up the levee slope than now, and the presently barren areas where the earlier placed riprap has eroded away, would be reshaped and recovered with new rock. The refinished length of the site would be 230 feet.

Site 3 is along the left bank at RM 130.0, downstream of the town of Sycamore, Colusa County. This site has previously been riprapped in 1940 (and possibly later), and also quite recently under unknown authority sometime between June 1998 and January 1999. Cobble, in the 6-10-inch class presently remains along all or most of the site, and it extends an average of about 17 feet up the levee slope above MSW.

The currently selected alternative is the "toe rock" option, which would include a toe trench and replanting of the existing riprap and berm with shrub vegetation. The few trees at the site would be retained. The new toe rock covering of quarry rock would not extend as far up the levee slope as the existing cobble rock, however. The refinished length of the site would be 360 feet.

Site 4 is on the right bank at RM 130.8, just upstream of site 3. The eroding reach is on the outside of a sharp bend in the river. This site was previously riprapped in 1936 and 1940, and possibly later. Remaining riprap consists of both cobble (8-10-inch) and quarry rock (>10-inch) remaining along about 95 percent of the site length and extending about 15 feet up the levee slope above the MSW.

The currently selected alternative at this site is the "bank fill rock slope and toe rock" approach, which would include a typical (*see* RM 149.0 action description) toe trench and shrub vegetation planting in the finished riprap. The new quarry rock covering would extend another 7-12 feet farther up the levee slope than existing riprap, and the presently barren areas scattered throughout the site would be reshaped and recovered with new rock. Rock ridges would be installed, and IWM would be derived from the secured 12 trees chosen on-site. The refinished length of the site would be 395 feet.

Site 5 is at RM 164.0, adjacent to the town of Princeton, Colusa County. The proposed bank protection area is in a relatively straight river reach just upstream of a moderate bend in the river. The entire bank and levee are composed of earthen substrates, which have not previously been riprapped.

The currently selected alternative for the site is the "bank fill rock slope" alternative, which would include a typical (*see* RM 149.0 action description) toe trench, toe rock, and replanting with shrub vegetation in disturbed areas and along the finished riprap. All riparian vegetation and IWM would be removed from the lower one-half of the bank. The finished riprap would extend from the toe trench up the reshaped slope about 20 vertical feet and 23 slope feet from MSW. Rock ridges would be installed and IWM derived from anchoring 48 trees, if river safety considerations allowed it. The finished site length would be 690 feet.

Other SRBPP Phase II Actions. It is reasonable to assume that a cost-sharing sponsor will be secured and that the SRBPP will utilize its remaining Phase II authority to construct approximately 30,000 lf of bank protection. Three sites have already been identified and extensively studied as requiring bank protection to address ongoing erosion. These sites, recently dropped from Contracts 42E and 42F, are likely future candidates for bank protection projects. The Basis of Design Report (Ayres and Associates 2000) includes site descriptions and estimated erosion rates for RM 26.9 and for RMs 43.1 and 43.3 combined. Given these sites' location within the action area for the SRBPP, and their high likelihood of becoming proposed actions in the near future, an analysis of the effects at these sites will be included in this biological opinion. Conservation measures for these sites are not directed at this time.

Site 6 is located at RM 26.9, on the left bank of the river near Walnut Grove, Sacramento County, just upstream from the Walnut Grove Bridge and Georgiana Slough. The channel is essentially straight, relatively narrow and deep, and there is a marina on the right bank opposite the erosion site. Wave wash from vessel traffic may be aggravating, if not causing the bulk of the erosion. The site is tidally influenced.

Historically, the site has been relatively stable and retains a significant amount of the original cobble riprap, placed in 1940. Recent erosion is apparently due to a small mass failure. A narrow sandy beach, 6 to 10 feet wide, exists along the site and provides habitat diversity greater than much of the adjoining banks. The upper portions of the bank possess narrow bands of trees and shrubs with herbaceous understory. Branches overhang the site and the beach has accumulated a moderate amount of LWD.

The currently selected alternative for RM 26.9, identified in the Basis of Design Report, is the "bank fill rock slope and tow protection" alternative, which would include a typical (*see* RM 149.0 action description) toe trench, rocked bank, and replanting of woody riparian vegetation in disturbed areas and along the finished quarry rock riprap. The beach and its associated LWD would be removed. The riprap would extend up to the average elevation of the existing, established vegetation. The refinished length of the site would be 330 feet. No offsite conservation measures have been proposed

Site 7 consists of RMs 43.1 and 43.3 being combined into a single site in the Corps' environmental documents. This proposed site is located on the right bank of the Sacramento River at 43.1 and 43.3 at Silver Bend, upstream from Clarksburg on the outside of a sharp bend. The site is subject to high velocities and scour from bendway hydraulics, and is tidally influenced.

Erosion at Site 7 is characterized by slow bankline retreat and more recently, small mass failures. Little of the cobble riprap installed in 1939 remains, indicating the site has retreated approximately 10 to 20 feet in 60 years. The estimated erosion rate is 0.3 ft per year.

Site 7 displays extensive overhanging riparian canopy cover and produces and retains large amounts of LWD. A bank of mature cottonwood and valley oak trees, along with an herbaceous understory, cover the upper bank slope. The middle and lower banks have patchy tree and shrub coverage. Many of the trees along the bank are falling into the river and serving as LWD. These fallen trees serve to snag additional LWD. Currently, a band of LWD, reaching up to 16 feet in width, is present along much of the site.

The currently selected alternative for Site 7 is the "bank fill rock slope and toe protection" alternative, which would include a typical (*see* RM 149.0 action description) toe trench and replanting of woody riparian vegetation in disturbed areas and along the finished quarry rock riprap. All LWD would be removed from the site, and the sinuous contours of the bank would be replaced with a hydraulically smooth, finished riprap surface. The riprap would extend up to the average elevation of the existing vegetation. The proposed project involves the replacement of 1,480 feet of eroding bank with a bank cut/toe rock structure. The middle and lower banks would be cleared of vegetation and riprapped while maintaining as many trees as possible on the upper banks. All LWD would be removed from along the site. No offsite conservation measures have been proposed.

Phase II of the SRBPP Approximately 30,000 lf of bank protection remains authorized within Phase II, exclusive of Sites 6 and 7. The SRBPP has been incrementally implemented for 40 years and has used the impact-avoidance technique of a setback levees only once, in Cache Slough, in an attempt at within-project mitigation banking. Based on the historical record, it can be assumed that SRBPP will continue to be implemented incrementally, and will primarily employ traditional riprap approaches (bank fill rock slope and/or toe protection) to address areas of high erosion.

The SRBPP has begun to implement experimental conservation measures intended to minimize the adverse effects of habitat loss on listed species from traditional riprapping. These experimental measures include multi-level, shallow vegetated benches within the riprap, planting in riprap, "scalloped" or "hard point" waterline banks with LWD pieces inserted into riprap, and the rock cluster/anchored LWD features as proposed for RM 149.0. USFWS staff noted that, in the dry winter of water year 2001, several of these sites were inundated only on the scale of days. In late 1999, at Girdner Bend on the Sacramento River, a biotechnical fix involving coconut coir matting, soil coverage with herbaceous vegetation, and revegetation, was implemented. The site subsequently failed and was subjected to an emergency application of riprap. Neither the biological efficacy and ecological functioning, or the longevity of these engineered measures has yet been demonstrated.

Mitigation Ratios

On June 20, 2001, a meeting between staff of NMFS, USFWS, the Corps, and the Reclamation Board was held to discuss issues related to NMFS' and USFWS' draft jeopardy biological opinions on the SRBPP. A specific request was made by Corps and Reclamation Board staff that they be provided a biological rationale for the 5:1 conservation ratio that had been incorporated into the Reasonable and Prudent Alternative section, and which has since been written into the project description.

The Corps and Reclamation Board staff noted that a 3:1 ratio appeared to be the standard applied to mitigation projects, as this is the highest possible ratio found in USFWS' *1998 Guidelines for Mitigation Impacts of 1998 Repairs under PL 84-99*. However, the actions proposed under the SRBPP differ significantly from those undertaken for PL 84-99, and it is these differences that, in part, explain the change from a 3:1 ratio to a 5:1 ratio.

The ratio is higher than typical because the arresting of erosion with riprap is fundamentally at odds with the natural fluvial processes that dictate the dimension, pattern, and profile of rivers and thus, the habitat to which native fish, wildlife, and plant species (including listed species) have evolved and upon which their recoveries depend.

Whereas, the Mitigation Policy response to PL 84-99 is structured to allow for retention of habitat values during and subsequent to the repair of sites damaged by floods or flood-fighting. PL 84-99 is only authorized to repair sites to their original standard and actions typically involving the replacement of damaged riprap with new riprap of modern specifications. The implementation of PL 84-99 is not fundamentally altering existing fluvial conditions. Also, the Mitigation Policy is based upon the retention, and not necessarily the enhancement of or increases in, habitat values.

The SRBPP, however, often results in the application of riprap to eroding, earthen banks or riprap beyond its original extent (for already-riprapped sites). The SRBPP may also upgrade existing riprap to a modern specification, if erosion has been documented. The SRBPP, by virtue of its application of riprap to earthen banks, can be expected to create greater impacts upon fluvial function than would bank protection taken under PL 84-99 authority. The present efforts under the SRBPP have been evaluated relative to their ability to comply with the ESA, whereas compliance with the Mitigation Policy does not imply compliance with the ESA.

The ESA requires that listed species be recovered and, via Section 7(a)(1), all Federal agencies are directed to assist in that recovery. Given that the SRBPP has direct and appreciable adverse effects on the natural fluvial function upon which listed fish species depend (see below), it is reasonable to expect that the burden for recovery, via conservation ratios, would be higher. The best professional judgment was exercised in setting that ratio at 5:1.

Implementation of the currently proposed, incremental SRBPP actions in Contracts 42E and 42F will result in the permanent loss of large woody debris (LWD) function from the individual sites specifically, and from the Sacramento River and Delta in general. The proposed Contract 42E project at river mile (RM) 149.0 includes the removal of 0.26 acres of riparian vegetation, the conversion of an estimated 743 linear feet (lf) of earthen banks to hydraulically smooth riprap, and the associated deprivation of LWD input and retention, the loss of river dynamics in 3,600 feet of meander bend, and a reduction in aquatic refugia components.

The currently proposed actions in Contract 42F involve similar effects on listed species. The proposed action at RM 85.6 would result in the cessation of significant LWD input over discontinuous portions of the 1,050 lf of bank at the site. The banks at RM 130.8 are relatively bare, but will be replaced with uniform quarry stone. It is likely that the instream woody material (logs and exposed root balls) present along 67 percent of the site will be removed, and that future contribution and retention of LWD will cease. The proposed action at RM 164.0 would eliminate LWD function from approximately 743 lf of the site.

Riprap creates laminar flow zones in near shore areas, and shifts erosive forces to more vertical vectors, thus deepening river channels. Sacramento River winter-run chinook salmon, Central Valley steelhead, and Central Valley spring-run chinook salmon are already suffering from massive habitat loss and changed hydrologic/hydraulic conditions, and any measure that worsens the condition is problematic.

Riprapping of earthen and actively eroding, riprapped banks also involves unknown effects on sediment supply and instream organic material. The Sacramento River and its major tributaries are all dammed, leaving river banks the primary source of the sediments and organic materials crucial to proper aquatic ecosystem function. Further riprapping of banks can permanently arrest this process.

The unproven measures proposed by the Corps were insufficient to offset these losses. The instream woody material (IWM) feature, as proposed for the RM 149.0 site, can only be considered experimental. Research has shown that engineered LWD replacement methods have proven largely ineffective. Further, woody riparian trees that are proposed for planting within the riprap are unlikely to contribute significant amounts of LWD to the river within a meaningful time frame. These trees must first mature, then die, before they can enter the river. Further, the trees would be fixed within revetment. This would allow only the contribution of small, broken fragments of wood and would prevent the most significant pieces of LWD, intact trees, from entering the river. USFWS therefore considers the riprapping of earthen or actively eroding, riprapped banks to be a near permanent loss of LWD function. The Corps' proposed use of lateral groins and other engineered, riprap-based structures to retain some hydraulic diversity is experimental and cannot be relied upon to offset the permanent losses of near shore microhabitat losses and refugia. At best, these technologies are considered experimental minimization, but not conservation, measures. The permanent loss of organic matter and sediment contribution has not been quantified, but any contribution made by these sites will be curtailed or completely halted by implementation of the proposed action. The implementation of the proposed actions at RMs 85.6, 123.5, 130.0, 130.8, 149.0, and 164.0 will involve appreciable losses of habitat for listed fish species. Habitat value of sites with actively eroding, 1940s-era riprap cannot be readily discounted. That these sites are eroding indicates they are achieving a greater amount of fluvial function with each passing year. Replacement of an incomplete coverage of eroding cobbles with a uniform surface of angular quarry stone is not without a significant impact to the aquatic environment.

III. STATUS OF THE LISTED SPECIES AND CRITICAL HABITAT

This Opinion analyzes the effects of the Sacramento River Bank Protection Project at Site RM149.0 and at five other sites along the mainstem Sacramento River on the federally endangered Sacramento River winter-run chinook salmon (*Oncorhynchus tshawytscha*), threatened Central Valley steelhead (*O. mykiss*), threatened Central Valley spring-run chinook salmon (*O. tshawytscha*), and their designated critical habitat, and on essential fish habitat within the action area.

The action area is defined by the area authorized under Phase II of the Sacramento River Bank Protection Project as the mainstem of the Sacramento River from RM 0 near Collinsville upstream to RM 194 at Chico Landing.

<u>Sacramento River Winter-run Chinook Salmon - Endangered: Population Trends, Life History, and Biological Requirements</u>

The Sacramento River winter-run chinook salmon is a unique population of chinook salmon in the Sacramento River. It is distinguishable from the other three Sacramento River chinook runs by the timing of its upstream migration and spawning season. NMFS listed winter-run chinook salmon as threatened (54 FR 10260) under emergency provisions of the ESA in August 1989 and the species was formally listed as threatened in November 1990 (55 FR 46515). The State of California listed winter-run chinook salmon as endangered in 1989 under the California State Endangered Species Act (CESA). On June 19, 1992 NMFS proposed that the winter-run chinook salmon be reclassified as an endangered species pursuant to the ESA (57 FR 27416). NMFS finalized its proposed rule and re-classified the winter-run as an endangered species under the ESA on January 4, 1994 (59 FR 440).

Prior to construction of Shasta and Keswick Dams in 1945 and 1950, respectively, winter-run chinook salmon were reported to spawn in the upper reaches of the Little Sacramento, McCloud, and lower Pitt Rivers (Moyle et al. 1989). Specific data relative to the historic run sizes of winter run chinook prior to 1967 are sparse and mostly anecdotal. Numerous fishery researchers have cited Slater (1963) to indicate that the winter-run chinook salmon population may have been fairly small and limited to the spring-fed areas of the McCloud River before the construction of Shasta Dam. However, CDFG research in California State Archives has cited several fisheries chronicles that indicate the winter-run chinook salmon population may have been much larger than previously thought. According to these qualitative and anecdotal accounts, the winter-run chinook salmon reproduced in the McCloud, Pit and Little Sacramento rivers and may have numbered over 200,000 (Rectenwald 1989). Construction of Shasta and Keswick Dams blocked access to all of the winter-run chinook salmon's historic spawning grounds.

The first winter-run chinook salmon migrants appear in the Sacramento-San Joaquin Delta during the early winter months (Skinner 1972). On the upper Sacramento River, the first upstream migrants appear during December (Vogel and Marine 1991). Due to the lack of fish passage facilities at Keswick Dam, adults tend to migrate to and hold in deep pools between Red Bluff Diversion Dam (RBDD) and Keswick before initiating spawning activities. The upstream migration of winter-run chinook salmon typically peaks during the month of March, but may vary with river flow, water-year type, and operation of RBDD.

Since the construction of Shasta and Keswick dams, winter-run chinook salmon spawning has primarily occurred between RBDD and Keswick Dam. The spawning period on winter-run chinook salmon generally extends from mid-April to mid-August with peak activity occurring in May and June (Vogel and Marine 1991). Aerial surveys of spawning redds have been conducted annually by the CDFG since 1987. The surveys have shown that the majority of winter-run chinook salmon spawning in the upper Sacramento River has occurred between the Anderson-Cottonwood Irrigation District (ACID) dam at RM 298 and the upper Anderson Bridge at RM 284. However, significant numbers of winter-run chinook salmon may also spawn below Red Bluff (RM 245) in some years. In 1988, for example, winter-run chinook salmon redds were observed as far downstream as Woodson Bridge (RM 218)(SRBPP 2000).

The only known self-sustaining population of winter-run chinook outside the Sacramento drainage occurred in the Calaveras River (NMFS 1997). Several dozen to several hundred adults, spawned below New Hogan Dam. The run was extirpated by the mid-80s, partially due to low flows in the Calaveras River, drought and irrigation diversions.

Most winter-run chinook salmon spawners are three years old. They spawn in gravel between 1.9 cm to 10.2 cm in diameter with no more than 5% fine sediment composition. Once spawning is completed, adult winter-run chinook salmon die. The eggs hatch after an incubation period of about 40-60 days depending on ambient water temperatures. Maximum survival of incubating eggs and pre-emergent fry occurs at water temperatures between 40°F and 56°F. Mortality of eggs and pre-emergent fry commences at 57.5°F and reaches 100 percent at 62°F (Boles et al. 1988). Other potential sources of mortality during the incubation period include redd dewatering, insufficient oxygenation, physical disturbance, and water-borne contaminants.

The pre-emergent fry remain in the redd and absorb the yolk stored in their yolk-sac as they grow into fry. This period of larval incubation lasts approximately 2 to 4 weeks depending on water temperatures. Emergence of the fry from the gravel begins during late June and continues through September. The fry seek out shallow nearshore areas with slow current and good cover, and begin feeding on small terrestrial and aquatic insects and aquatic crustaceans. As they grow from 50 to 75 mm in length, the juvenile salmon move out into deeper, swifter water, but continue to use available cover to minimize the risk of predation and reduce energy expenditure.

The emigration of juvenile winter-run chinook salmon from the upper Sacramento River is dependent on streamflow conditions and water-year type. Once fry have emerged, storm events may cause en masse emigration pulses. This emigration past Red Bluff may occur as early as late July or August, generally peaks in September, and can continue until mid-March in drier years (Vogel and Marine 1991). Emigration past Glenn Colusa Irrigation District (GCID) at RM

206 is monitored daily by CDFG with a rotary screw trap in the GCID oxbow. The CDFG trap data show that juvenile winter-run chinook salmon emigration past GCID begins as early as mid-July and may continue throughout April (HDR Engineering Inc. 1993). Data combined from 1981-1992 trapping and seining efforts show that winter-run chinook salmon outmigrants occur between early July and early May from Keswick to Princeton (RM 302 to RM 158), and data combined from trawling, seining and State and Federal water project fish salvage records in the Delta show that winter-run chinook salmon outmigrants occur from October to early May in the Sacramento-San Joaquin Delta (DFG 1993). Data analysis collected from mark-recapture studies in the Sacramento River, 1996-1997-1998, concluded that 40% of winter-run chinook salmon population emigrated past Knights Landing in early to mid-December (DFG, 2000a, 2000b). Emigration from the Delta might begin to occur as early as late-December and continue through June. Smolts enter the ocean at an average fork length of approximately 118 mm. The period of residency in the Sacramento River and Delta for Sacramento River winter-run chinook salmon is between five and nine months.

Completion of the Red Bluff Diversion Dam (RBDD) in 1966 enabled accurate estimates of all salmon runs to the upper Sacramento River based on fish counts at the fish ladders. Since the 1989 emergency listing of Sacramento River winter-run chinook, the population has been very low but has recently shown some improvements. Escapement declined from 533 in 1989, to 441 and 191 fish in 1990 and 1991, respectively. In 1992, the population rebounded to1180 fish, but declined again in 1993 and 1994 to 341 and 189, respectively, before rebounding again in 1995 to 1361 fish. Returns from the 1993 and 1994 cohorts have increased considerably to 940 and 841 fish. Returns were estimated at between 2,500 and 2,600 fish in 1998, and at 1,204 fish in 2000. Still, spawning adult numbers are close or above the threshold escapement level of 500 spawning adults.

To evaluate whether these population abundances represent an increasing or decreasing trend, the cohort survival of several year classes can be examined based on the winter-run chinook population's age structure. To estimate cohort survival, two assumptions are made: 1) consider only adult returns (exclude jacks), and 2) all females mature at age three. Cohort survival can be represented as a cohort replacement rate (CRR), or the ratio between the number of spawning adults in one generation to the number of spawning adults in the next generation.

For the years since listing, approximate calculations of CRR are shown in Table 1. The geometric mean for three recent year classes (1993-1995 brood years) is 2.02. Considering cohort survival in brood years preceding the listing, it appears that the steep downward trend observed in the population before listing may be closer to stabilizing.

Table 1. Estimates of winter-run chinook salmon run-size, spawning adults and corresponding cohort replacement rates.

Broodyear	Total Run-size	Number of Adults	CRR
1985	3962	3633	0.38
1986	2464	2013	0.24
1987	1997	1761	0.25
1988	2094	1386	0.10
1989	533	480	2.34
1990	441	435	0.61
1991	191	133	1.15
1992	1180	1122	1.16
1993	341	267	1.97
1994	189	153	3.24
1995	1361	1296	1.38
1996	940	527	1.90
1997	841	496	-
1998	~2500	1784	-
1999	3208	1001	-
2000	1204		

An important aspect contributing to uncertainty is the accuracy of escapement estimates. Prior to 1986, the entire winter-run chinook population was monitored during the course of their upmigration past RBDD. Beginning in 1986, the gates at RBDD have been raised for various time periods during their migration to enable freer passage to spawning grounds. Since 1990, the gates have been raised for up to 85% of the winter-run upmigration period, such that about 15% of the run has been monitored rather than the entire run. This monitoring level equates to a sampling accuracy with a variance of 1.0 (in logarithms), such that the ratio of estimated to actual values varies between 0.36 and 2.72 (± 1 standard deviation). For example, the 1994 year class had an escapement estimate of 189 spawning adults, but the accuracy of this estimate is fairly low, such that the actual run-size may have varied between 68 and 514 adults. The winter-run chinook salmon will be considered as recovered when the mean annual spawning abundance over any 13 consecutive years is 10,000 females (NMFS 1997).

Winter-run chinook salmon are very susceptible to extinction because the species is limited to a single, isolated population without a source of immigration from subpopulations (NMFS 1997). The winter-run chinook have a lower fecundity than most other chinook populations and therefore have a lower reproductive potential average of 3,353 eggs per female, vs. Central

Valley fall-run chinook at 5,498 eggs per female, Columbia River chinook salmon at 5,032-5,453 eggs per female, and Alaskan chinook populations averaging 5,000 eggs per female) (Fisher 1994; Healey and Heard 1984).

Sacramento River Winter-run Chinook Salmon Critical Habitat

Critical habitat for Sacramento River winter-run chinook salmon was designated on June 16, 1993 (58 FR 33212). Critical habitat is designated to include: the Sacramento River from Keswick Dam (RM 302) to Chipps Island (RM 0) at the westward margin of the Sacramento-San Joaquin Delta; all waters from Chipps Island westward to Carquinez Bridge, including Honker Bay, Grizzly Bay, Suisun Bay, and Carquinez Strait; all waters of San Pablo Bay westward of the Carquinez Bridge; and all waters of San Francisco Bay to the Golden Gate Bridge north of the San Francisco/Oakland Bay Bridge. Within the Sacramento River, this designation includes the river water column, the river bottom (including those areas and the associated gravel used by Sacramento River winter-run chinook salmon for spawning substrate), and the adjacent riparian zone used by fry and juveniles for rearing. In the areas westward from Chipps Island, including San Francisco Bay to the Golden Gate Bridge north of the San Francisco/Oakland Bay Bridge, this designation includes the estuarine water column and essential foraging habitat and food resources utilized by Sacramento River winter-run chinook salmon as part of their juvenile emigration or adult spawning migration.

Central Valley Steelhead - Threatened: Population Trends, Life History, and Biological Requirements

On March 19, 1998, NMFS listed Central Valley steelhead as threatened under the Endangered Species Act (63 FR 13347). Central Valley steelhead once ranged throughout most of the tributaries and headwaters of the Sacramento and San Joaquin basins prior to dam construction, water development, and watershed perturbations of the 19th and 20th centuries (McEwan and Jackson 1996). Historical documentation exists that show steelhead were once widespread throughout the San Joaquin River system (CALFED 1999). In the early 1960s, the California Fish and Wildlife Plan estimated a total run size of about 40,000 adults for the entire Central Valley including San Francisco Bay. The annual run size for this ESU in 1991-92 was probably less than 10,000 fish based on dam counts, hatchery returns and past spawning surveys (McEwan and Jackson 1996).

Estimates of steelhead historical habitat can be based on estimates of salmon historical habitat. The extent of habitat loss for steelhead is probably greater than losses for salmon, because steelhead go higher into the drainages than do chinook salmon (Yoshiyama et al.1996). Clark (1929) estimated that originally there were 6,000 miles of salmon habitat in the Central Valley system and that 80% of this habitat had been lost by 1928. Yoshiyama et al. (1996) calculated that roughly 2,000 miles of salmon habitat was actually available before dam construction and mining, and concluded that 82% of what was present is not accessible today. Clark (1929) did not give details about his calculation. Whether Clark's or Yoshiyama's calculation is used, only remnants of the former steelhead range remain accessible today in the Central Valley.

As with most Central Valley chinook, impassable dams block access to most of the historical headwater spawning and rearing habitat of Central Valley steelhead. In addition, much of the remaining, accessible spawning and rearing habitat is severely degraded by elevated water temperatures, agricultural and municipal water diversions, unscreened and poorly screened water intakes, restricted and regulated streamflows, levee and bank stabilization, and poor quality and quantity of riparian and SRA cover.

At present, wild steelhead stocks are mostly confined to upper Sacramento River tributaries such as Antelope, Deer, and Mill creeks and the Yuba River (McEwan and Jackson 1996). Naturally spawning populations are also known to occur in Butte Creek, and the upper Sacramento, Feather, American, Mokelumne, and Stanislaus rivers (CALFED 1999). However, the presence of naturally spawning populations appears to correlate well with the presence of fisheries monitoring programs, and recent implementation of new monitoring efforts has found steelhead in streams previously thought not to contain a population, such as Auburn Ravine, Dry Creek, and the Stanislaus River (IEP Steelhead Project Work Team 1999). It is possible that other naturally spawning populations exist in Central Valley streams, but are undetected due to lack of monitoring or research programs (IEP Steelhead Project Work Team 1999).

All Central Valley steelhead are considered winter-run steelhead (McEwan and Jackson 1996), although there are indications that summer steelhead were present in the Sacramento River system prior to the commencement of large-scale dam construction in the 1940's (IEP Steelhead Project Work Team 1999). Adult steelhead migrate upstream in the Sacramento River mainstem from July through March, with peaks in September and February (Bailey 1954; Hallock et al. 1961). The timing of upstream migration is generally correlated with higher flow events, such as freshets or sand bar breaches, and associated lower water temperatures. The preferred temperatures for upstream migration are between 46° F and 52° F (Reiser and Bjornn 1979, Bovee 1978, Bell 1986). Unusual stream temperatures during upstream migration periods can alter or delay migration timing, accelerate or retard mutations, and increase fish susceptibility to diseases. The minimum water depth necessary for successful upstream passage is 18 cm (Thompson 1972). Velocities of 3-4 meters per second approach the upper swimming ability of steelhead and may retard upstream migration (Reiser and Bjornn 1979).

Using a combination of olefaction, visual cues, current patterns and possibly magnetism, adult steelhead home in on the stream of their origin. This mechanism likely takes advantage of localized adaptations for survival and thus ensures survival of offspring. The adults will hold in the main river until there is enough runoff to ascent into the tributaries; as they enter the cold, fresh water, they also reach peak sexual maturity. The adults need cover once they are in the river channel, and will often move at night or in the muddy waters of storm flows to avoid predation. Steelhead can swim against strong currents, but may have to seek refuge (pools, backwater) during high flow events. Steelhead can spawn in either a tributary or the main river channel. In spawning, all steelhead need rivers with cold, well-oxygenated water and a channel bed with medium sized rocks, 1-4 inches in diameter. Siltation will smother the eggs, so it is critical that the river does not have an excessive sediment load. The spawning site is usually at the head of a riffle, a glide, or downstream end of a pool.

Spawning may begin as early as late December and can extend into April with peaks from January through March (Hallock et al. 1961). Unlike chinook salmon, not all steelhead die after spawning. Some may return to the ocean and repeat the spawning cycle for two or three years; however, the percentage of repeat spawners is generally low (Busby et al. 1996). Steelhead spawn in cool, clear streams featuring suitable gravel size, depth, and current velocity. Intermittent streams may be used for spawning (Barnhart 1986; Everest 1973). Gravels of 1.3 cm to 11.7 cm in diameter (Reiser and Bjornn 1979) and flows of approximately 40-90 cm/second (Smith 1973) are generally preferred by steelhead. Reiser and Bjornn (1979) reported that steelhead prefer a water depth of 24 cm or more for spawning. The survival of embryos is reduced when fines of less than 6.4 mm comprise 20 - 25% of the substrate. Studies have shown a survival of embryos improves when intragravel velocities exceed 20 cm/hour (Phillips and Campbell 1961, Coble 1961). The preferred temperatures for spawning are between 39° F and 52° F (McEwan and Jackson 1996).

The length of time required for eggs to develop and hatch is dependant on water temperature and is quite variable; hatching varies from about 19 days at an average temperature of 60° F to about 80 days at an average of 42° F. The optimum temperature range for steelhead egg incubation is 46° F to 52° F (Reiser and Bjornn 1979, Bovee 1978, Bell 1986, Leidy et al.1987). Egg mortality may begin at temperatures above 56° F (McEwan and Jackson 1996).

After hatching, pre-emergent fry remain in the gravel living on yolk-sac reserves for another four to six weeks, but factors such as redd depth, gravel size, siltation, and temperature can speed or retard this time (Shapovalov and Taft 1954). Upon emergence, steelhead fry typically inhabit shallow water along perennial stream banks. Older fry establish territories which they defend. Streamside vegetation is essential for foraging, cover, and general habitat diversity. Steelhead juveniles are usually associated with the bottom of the stream. In winter, they become inactive and hide in available cover, including gravel or woody debris.

The majority of steelhead in their first year of life occupy riffles, although some larger fish inhabit pools or deeper runs. Juvenile steelhead feed on a wide variety of aquatic and terrestrial insects, and emerging fry are sometimes preyed upon by older juveniles. Water temperatures influence the growth rate, population density, swimming ability, ability to capture and metabolize food, and ability to withstand disease of these rearing juveniles (Leidy et al. 1987). Rearing steelhead juveniles prefer water temperatures of 45° F to 60° F (Reiser and Bjornn 1979, Bovee 1978, Bell 1986). Temperatures above 60° F have been determined to induce varying degrees of chronic stress and associated physiological responses in juvenile steelhead (Leidy et al. 1987).

After spending one to three years in freshwater, juvenile steelhead migrate downstream to the ocean. Most Central Valley steelhead migrate to the ocean after spending two years in freshwater (Hallock et al. 1961, Hallock 1989). Barnhart (1986) reported that steelhead smolts in California range in size from 14 to 21 cm (fork length). In preparation for their entry into a saline environment, juvenile steelhead undergo physiological transformations known as smoltification that adapt them for their transition to salt water. These transformations include different swimming behavior and proficiency, lower swimming stamina, and increased buoyancy that also make the fish more likely to be passively transported by currents (Folmar and Dickhoff 1980, Smith 1982). In general, smoltification is timed to be completed as fish are near the fresh water to salt water transition. Too long a migration delay after the process begins is believed to cause the fish to miss the "biological window" of optimal physiological condition for the transition (Walters et al. 1978). The optimal thermal range during smoltification and seaward migration for steelhead is 44° F to 52° F (Leidy et al.1987, Rich 1997) and temperatures above 55.4° F have been observed to inhibit formation and decrease activity of gill (Na and K) ATPase activity in steelhead, with concomitant reductions in migratory behavior and seawater survival (Zaugg and Wagner 1973, Adams et. al 1973). Hallock et al. (1961) found that juvenile steelhead in the Sacramento Basin migrated downstream during most months of the year, but the peak period of emigration occurred in the spring, with a much smaller peak in the fall.

Steelhead spend between one and four years in the ocean (usually one to two years in the Central Valley) before returning to their natal streams to spawn (Barnhart 1986, Busby et al. 1996).

The current state of Central Valley steelhead runs is a precarious one. Studies on steelhead have lagged behind those conducted for the salmon species. Recent wet years have afforded opportunity for steelhead to occupy rivers where they were thought to be previously extirpated (D. Smith, U.S.Forestry Service, personal communication, March 2000). Increased monitoring and habitat restoration need to be conducted to bring the steelhead back from their "threatened" status.

Central Valley Steelhead Critical Habitat

On February 5, 1999 NMFS proposed the designation of critical habitat for the Central Valley steelhead (64 FR 5740). The final rule designating steelhead critical habitat was issued on February 16, 2000 (65 FR 7764). Critical habitat consists of the water, substrate, and adjacent riparian zone of accessible estuarine and riverine reaches. Accessible reaches are those within the historical range of the ESU that can still be occupied by any life stage of steelhead. Inaccessible reaches are those above longstanding, naturally impassable barriers (i.e., natural waterfalls in existence for at least several hundred years) and specific dams within the historical range of each ESU.

Critical habitat for Central Valley steelhead is designated to include all river reaches accessible to listed steelhead in the Sacramento and San Joaquin Rivers and their tributaries in California. Also included are river reaches and estuarine areas of the Sacramento-San Joaquin Delta, all waters from Chipps Island westward to Carquinez Bridge, including Honker Bay, Grizzly Bay, Suisun Bay, and Carquinez Strait, all waters of San Pablo Bay westward of the Carquinez Bridge, and all waters of San Francisco Bay (north of the San Francisco/Oakland Bay Bridge) from San Pablo Bay to the Golden Gate Bridge. Excluded are areas of the San Joaquin River upstream of the Merced River confluence and areas above specific dams (Black Butte Dam, Centerville Dam, Oroville Dam, Camp Far West Dam, Monticello Dam, Nimbus Dam, Keswick Dam, Whiskeytown Dam, Englebright Dam, Crocker Diversion Dam, La Grange Dam, Commache Dam, Goodwin Dam, and New Hogan Dam) or above longstanding naturally impassable barriers.

Central Valley Spring-run Chinook Salmon - Threatened: Population Trends, Life History, and Biological Requirements

On September 16, 1999, NMFS listed Central Valley spring-run chinook salmon as threatened under the Endangered Species Act (64 FR 50394). Historically, spring-run chinook salmon were predominant throughout the Central Valley, occupying the upper and middle reaches of the San Joaquin, American, Yuba, Feather, Sacramento, McCloud, and Pit Rivers, with smaller populations in most other tributaries with sufficient habitat for over-summering adults (Clark 1929). The Central Valley drainage as a whole is estimated to have supported spring-run chinook salmon runs as large as 600,000 fish between the late 1880s and 1940s (DFG 1998). Before the construction of Friant Dam, nearly 50,000 adults were counted in the San Joaquin River (Fry 1961). Following the completion of Friant Dam, the native population from the San Joaquin River and its tributaries was extirpated. Also, spring-run chinook salmon no longer exist in the American River due to Folsom Dam.

Clark (1929) estimated that originally there were 6,000 miles of salmon habitat in the Central Valley system and that 80% of this habitat had been lost by 1928. Yoshiyama et al. (1996) calculated that roughly 2,000 miles of salmon habitat was actually available before dam construction and mining, and concluded that 82% is not accessible today, and only remnants of their former range remain accessible in the Central Valley (DFG 1998).

Spring-run chinook salmon run timing was adapted for gaining access to the upper reaches of river systems, 1,500 to 5,200 feet in elevation, prior to onset of high water temperatures and low flows. Impassable dams now block access to most of the historical headwater spawning and rearing habitat of Central Valley spring-run chinook salmon. In addition, much of the remaining, accessible spawning and rearing habitat is severely degraded by elevated water temperatures, agricultural and municipal water diversions, unscreened and poorly screened water intakes, restricted and regulated streamflows, levee and bank stabilization, and poor quality and quantity of riparian and shaded riverine aquatic cover (SRBPP 2000). Juvenile spring-run rear in non-natal tributaries to the Sacramento River including the lower reaches of small, intermittent streams (Maslin et al.1997). Only ten river systems have any spring-run chinook salmon, reduced from at least 22 major rivers and tributaries in the Central Valley (SRBPP 2000). Six of these systems contain non-sustaining or genetically questionable populations due to the delay in migration resulting from artificial barriers (SRBPP 2000).

A significant portion of the Central Valley spring-run chinook salmon ESU spawn and rear in upstream reaches of the Sacramento River. Since the majority of spring-run chinook historical spawning and rearing habitat in the Sacramento and San Joaquin River basins is no longer accessible due to impassable dams, the accessible areas of the Feather River, Clear Creek, and upper Sacramento River and tributaries including Butte, Mill and Deer Creek, Big Chico represent an essential portion of the remaining range and critical habitat for Central Valley spring-run chinook salmon.

Historically, the Sacramento River downstream of Shasta Dam was used by spring-run as a migration route to and from cooler tributary streams. After the construction of Keswick Dam in May 1942, Moffett (1947) estimated that 25,000 spring-run chinook salmon spawned in this area of the mainstem Sacramento River. From 1947 until 1956, estimates of spring-run abundance in the Sacramento River were based on redd counts and ranged from 27,000 to 4,000 (DFG 1998). No estimates were made from 1957 through 1968. Starting in 1969, spring-run estimates were based on counts made at Red Bluff Diversion Dam (RBDD) which included fish that were destined for Battle and Cottonwood Creeks. Since estimates of spring-run escapements are also separately generated for these drainages, some fish are "double counted" and no analysis has been performed to adjust the RBDD estimates to account strictly for the spawners to the mainstem Sacramento River. From 1991-1997, counts at RBDD have been below 800 spring-run chinook salmon and in 1997 had declined to 189 fish.

Due to poor estimates of run size and large variations in annual escapements between Central Valley streams, the percentage of the ESU spawning and rearing within the Sacramento River cannot be determined. However, the upper Sacramento River, Feather River, and Clear Creek represent approximately one-quarter of the remaining accessible spawning streams in the Central Valley.

Natural spawning populations of Central Valley spring-run chinook salmon are currently restricted to accessible reaches in the upper Sacramento River, Antelope Creek, Battle Creek, Beegum Creek, Big Chico Creek, Butte Creek, Clear Creek, Deer Creek, Feather River, Mill Creek, and Yuba River (DFG 1998; FWS, unpublished data). With the exception of Butte Creek and the Feather River, these populations are relatively small ranging from a few fish to several hundred. Butte Creek returns in 1998 and 1999 numbered approximately 20,000 and 3,600, respectively (DFG unpublished data). On the Feather River, significant numbers of spring-run chinook, as identified by run timing, return to the Feather River Hatchery. However, coded-wire-tag information from these hatchery returns indicates substantial introgression has occurred between fall-run and spring-run chinook populations in the Feather River due to hatchery practices. Over time, the spring-run within the Feather River may become homogeneous with Feather River fall-run fish unless current hatchery practices are changed (DFG 1998).

Spring-run chinook salmon adults are estimated to leave the ocean and enter the Sacramento River from March to July (Myers et al. 1998). This run timing is well adapted for gaining access to the upper reaches of river systems, 1,500 to 5,200 feet in elevation, prior to the onset of high water temperatures and low flows that would inhibit access to these areas during the fall. Throughout this upstream migration phase, adults require streamflows sufficient to provide olfactory and other orientation cues used to locate their natal streams. Adequate streamflows are also necessary to allow adult passage to upstream holding habitat in natal tributary streams. The preferred temperature range for spring-run chinook salmon completing their upstream migration is 38° F to 56° F (Bell 1991; DFG 1998).

When they enter freshwater, spring-run chinook salmon are immature and they must stage for several months before spawning. Their gonads mature during their summer holding period in freshwater. Over-summering adults require cold-water refuges such as deep pools to conserve energy for gamete production, redd construction, spawning, and redd guarding. The upper limit of the optimal temperature range for adults holding while eggs are maturing is 59° F to 60° F (Hinz 1959). Unusual stream temperatures during spawning migration and adult holding periods can alter or delay migration timing, accelerate or retard mutations, and increase fish susceptibility to diseases. Sustained water temperatures above 80.6° F are lethal to adults (Cramer and Hammack 1952; DFG 1998).

Adults prefer to hold in deep pools with moderate water velocities and bedrock substrate and avoid cobble, gravel, sand, and especially silt substrate in pools (Sato and Moyle 1989). Optimal water velocities for adult chinook salmon holding pools range between 0.5-1.3 feet-per-second and depths are at least three to ten feet (Marcotte 1984). The pools typically have a large bubble curtain at the head, underwater rocky ledges, and shade cover throughout the day (Ekman 1987).

Spawning typically occurs between late-August and early October with a peak in September. Once spawning is completed, adult spring-run chinook salmon die. Spawning typically occurs in gravel beds that are located at the tails of holding pools (USFWS 1995). Spring-run adults have been observed spawning in water depths of 0.8 feet or more, and water velocities from 1.2-3.5 feet-per-second (Puckett and Hinton 1974). Eggs, average ranging from 1,350 to 7,193, are deposited within the gravel where incubation, hatching, and subsequent emergence takes place. Optimum substrate for embryos is a mixture of gravel and cobble with a mean diameter of one to four inches with less than 5% fines, which are less than or equal to 0.3 inches in diameter (DFG 1998, Platts et al.1979, Reiser and Bjornn 1979). The upper preferred water temperature for spawning adult chinook salmon is 55° F to 57° F (Reiser and Bjornn 1979).

Length of time required for eggs to develop and hatch is dependant on water temperature and is quite variable, however, hatching generally occurs within 40 to 60 days of fertilization (Vogel and Marine 1991). In Deer and Mill creeks, embryos hatch following a 3-5 month incubation period (USFWS 1995). The optimum temperature range for chinook salmon egg incubation is 44° F to 54° F (Rich 1997). Incubating eggs show reduced egg viability and increased mortality at temperatures greater than 58° F and show 100% mortality for temperatures greater than 63° F (Velson 1987). Velson (1987) and Beacham and Murray (1990) found that developing chinook salmon embryos exposed to water temperatures of 35° F or less before the eyed stage experienced

100% mortality (DFG 1998). After hatching, pre-emergent fry remain in the gravel living on yolk-sac reserves for another two to four weeks until emergence. Timing of emergence within different drainages is strongly influenced by water temperature. Emergence of spring-run chinook typically occurs from November through January in Butte and Big Chico Creeks and from January through March in Mill and Deer Creeks (DFG 1998).

Post-emergent fry seek out shallow, nearshore areas with slow current and good cover, and begin feeding on small terrestrial and aquatic insects and aquatic crustaceans. As they grow to 50 to 75 mm in length, the juvenile salmon move out into deeper, swifter water, but continue to use available cover to minimize the risk of predation and reduce energy expenditure. The optimum temperature range for rearing chinook salmon fry is 50° F to 55° F (Boles et al. 1988, Rich 1997, Seymour 1956) and for fingerlings is 55° F to 60° F (Rich 1997).

In Deer and Mill creeks, juvenile spring-run chinook, during most years, spend 9-10 months in the streams, although some may spend as long as 18 months in freshwater. Spring-run chinook salmon appear to emigrate at two different life stages: fry or as yearlings. Fry move between February and June, while the yearling spring-run emigrate October to March, peaking in November (SRBPP 2000). Most of the yearling spring-run chinook move downstream in the first high flows of the winter from November through January (USFWS 1995, DFG 1998). In Butte and Big Chico creeks, spring-run chinook juveniles typically exit their natal tributaries soon after emergence during December and January, while some remain throughout the summer and exit the following fall as yearlings (DFG 1998). In the Sacramento River and other tributaries, juveniles may begin migrating downstream almost immediately following emergence from the gravel with emigration occurring from December through March (Moyle, et al. 1989, Vogel and Marine 1991). Fry and parr may spend time rearing within riverine and/or estuarine habitats including natal tributaries, the Sacramento River, non-natal tributaries to the Sacramento River, and the Delta. In general, emigrating juveniles that are younger reside longer in estuaries such as the Delta (Kjelson et al. 1982, Levy and Northcote 1982, Healey 1991). The brackish water areas in estuaries moderate the physiological stress that occurs during parr-smolt transitions. Although fry and fingerlings can enter the Delta as early as January and as late as June, their length of residency within the Delta is unknown but probably lessens as the season progresses into the late spring months (DFG 1998).

Spring-run chinook salmon rear in natal and non-natal streams, and continue to rear in the mainstem Sacramento River. All of the emigrating juvenile sub-yearling and yearling Central Valley spring-run chinook use the lower reach of the Sacramento River and the Delta for rearing and as migration corridor to the ocean. The lower American River may be utilized as non-natal rearing habitat depending on water temperatures. Some juveniles utilize tidal and non-tidal freshwater marshes and other shallow water areas in the Delta as rearing areas for short periods prior to the final portion of their emigration to the sea. All adult spring-run chinook salmon use the Delta and lower Sacramento River as an upstream migration corridor to return to their natal streams for spawning.

In preparation for their entry into a saline environment, juvenile salmon undergo physiological transformations known as smoltification that adapt them for their transition to salt water (Hoar 1976). These transformations include different swimming behavior and proficiency, lower swimming stamina, and increased buoyancy that also make the fish more likely to be passively transported by currents (Folmar and Dickhoff 1980, Smith 1982). In general, smoltification is timed to be completed as fish are near the fresh water to salt water transition. Too long a migration delay after the process begins is believed to cause the fish to miss the "biological window" of optimal physiological condition for the transition (Walters et al. 1978). The optimal thermal range for chinook during smoltification and seaward migration is 50° F to 55° F (Rich 1997).

Chinook salmon spend between one and four years in the ocean before returning to their natal streams to spawn (Myers et al. 1998). Fisher (1994) reported that 87% of returning spring-run adults are three-years-old based on observations of adult chinook trapped and examined at Red Bluff Diversion Dam between 1985 and 1991.

Spring-run chinook salmon populations are relatively small with sharply declining trends. The species cannot access most of their historical spawning and rearing habitats in the Sacramento and San Joaquin River basins due to impassable dams; therefore spawning is now restricted to the mainstem Sacramento River and a few upper tributaries. Threats to the continued existence of the spring-run include: elevated water temperatures, agricultural, municipal, and unscreened diversions, restricted and regulated flows, levee and bank stabilization, and poor quality and quantity of riparian and shaded riverine aquatic habitat, and compromised genetic integrity due to hybridization with non-spring-run chinook salmon.

Central Valley Spring-run Chinook Critical Habitat

On March 9, 1998 NMFS proposed the designation of critical habitat for the Central Valley spring-run chinook salmon (63 FR 11482). The final rule designating Central Valley spring-run chinook salmon critical habitat was issued on February 16, 2000 (65 FR 7764). Critical habitat consists of the water, substrate, and adjacent riparian zone of accessible estuarine and riverine reaches. Accessible reaches are those within the historical range of the Central Valley spring-run chinook Evolutionarily Significant Unit (ESU) that can still be occupied by any life stage of chinook salmon. Inaccessible reaches are those above longstanding, naturally impassable barriers (i.e., natural waterfalls in existence for at least several hundred years) and specific dams within the historical range of each ESU.

Critical habitat for Central Valley spring-run chinook is designated to include all river reaches accessible to chinook salmon in the Sacramento River and its tributaries in California. Also included are river reaches and estuarine areas of the Sacramento-San Joaquin Delta, all waters from Chipps Island westward to Carquinez Bridge, including Honker Bay, Grizzly Bay, Suisun Bay, and Carquinez Strait, all waters of San Pablo Bay westward of the Carquinez Bridge, and all waters of San Francisco Bay (north of the San Francisco/Oakland Bay Bridge) from San Pablo

Bay to the Golden Gate Bridge. Excluded are areas above specific dams or above longstanding naturally impassable barriers.

IV. ENVIRONMENTAL BASELINE

The action area is the mainstem of the Sacramento River from RM 0 near Collinsville upstream to RM 194 at Chico Landing. Federally-listed species that occur within the action area include the endangered Sacramento River winter-run chinook salmon, the threatened Central Valley steelhead, and the threatened Central Valley spring-run chinook salmon.

A. Status of the Species in the Action Area

Sacramento Winter-run Chinook Salmon

Sacramento River winter-run chinook salmon are currently only present in the Sacramento River below Keswick Dam, and are composed of a single, breeding population (NMFS 1997) (see Status of the Listed Species). Winter-run chinook spawn and rear exclusively in the upper Sacramento River, and are found in the project area seasonally as adults, fry and juveniles (DFG 2000a). Adult winter-run enter the San Francisco Bay from November through June (Van Woert 1958), and migrate up the Sacramento River from December through early August. The majority of the run passes Red Bluff Diversion Dam between January and May, peaking in mid-March (Hallock and Fisher 1985). Fry emerge from mid-June through mid-October, and may mass-migrate through storm events (NMFS 1997).

The emigration of juvenile winter-run chinook salmon from the Upper Sacramento River is dependent on streamflow conditions and water type. Emigration past Red Bluff (RM 242) may begin in late July, generally peaks in September, and can continue until mid-March in drier years (Vogel and Marine 1991). The peak emigration of winter-run chinook juveniles past the project reach corridor generally occurs from September through February, but the range of emigration may extend up to June (Schaffer 1980, Messersmith 1966, DFG 1989, DFG Memo 1993, USFWS 1992, USFWS 1993, USFWS 1994). Winter-run juveniles may utilize Sacramento tributary streams and intermittent tributary streams as non-natal rearing habitat (Maslin et al.1996a, 1996b). In some cases, intermittent tributaries can provide spawning habitat for salmonids when conditions are favorable.

The entire action area lies within designated critical habitat of the Sacramento River winter-run chinook salmon. Critical habitat within the action area ranges from shaded riverine aquatic habitat to estuarine areas. The essential elements of critical habitat in these areas are the water, substrate, and adjacent riparian areas.

Central Valley Steelhead

This stock represents all the known populations of steelhead within the ESU. Estimates of this stock ranged from 27,000 to 40,000 in the 1960s (Hallock et al.1961). Based on dam counts, hatchery returns, and past spawning surveys, the count as of 1996 was probably less than 10,000. Likewise, their critical habitat has been appreciably reduced from 6,000 miles historically to 300 miles at present (NMFS 1996; McEwan 1997).

Most steelhead adults migrate upstream in the Sacramento River between December and March to spawn (DFG 2000). The steelhead spawning season in the Sacramento River Basin is typically from December through April with peak activity occurring from January through March (McEwan and Jackson 1996). Keswick Dam releases of 3,250 to 7,000 cfs combined with tributary accretions are expected to provide adequate depths and velocities for upstream passage of migrating adults and for spawning. Predicted average monthly temperatures are within the range of preferred spawning temperatures for steelhead.

A significant portion of the Central Valley steelhead ESU spawn and rear within the action area. Since the majority of Central Valley steelhead historical spawning and rearing habitat in the Sacramento and San Joaquin River basins is no longer accessible due to impassable dams, the accessible areas of the upper Sacramento River represent an essential portion of the critical habitat for this steelhead ESU.

Central Valley steelhead populations within the action area generally show a continuing population decline, an overall low population abundance, and fluctuating return rates. Historical abundance estimates are available for some stocks within the action area but no overall reliable estimates are available. Monitoring of steelhead populations in the Sacramento and its tributaries is limited to the direct counts made at the RBDD, Feather River Fish Hatchery, and Nimbus Fish Hatchery.

All emigrating juvenile Central Valley steelhead smolts use the lower reaches of the Sacramento and San Joaquin rivers and the Delta for rearing and as migration corridor to the ocean. Some juveniles may utilize tidal and non-tidal freshwater marshes and other shallow water areas in the Delta as rearing areas for short periods prior to the final portion of their emigration to the sea. All adult steelhead use the Delta and lower reaches of the Sacramento and San Joaquin rivers as an upstream migration corridor to return to their natal streams for spawning.

The action area is located within the critical habitat of the Central Valley steelhead. Critical habitat within the action area ranges from riverine habitat to estuarine areas. The essential elements of critical habitat in these areas are the water, substrate, and adjacent riparian areas.

Central Valley Spring-run Chinook Salmon

Central Valley spring-run chinook populations currently spawn within the action area, below Keswick Dam and some of its tributaries including Mill, Deer, and Butte creeks (DFG 1998). Adult spring-run chinook salmon enter the mainstem Sacramento River in February and March, and continue to their spawning streams where they then hold in deep, cold pools until they spawn (DFG 2000b). Migration into the lower Yuba River occurs between March and August; into Deer, Mill and Butte creeks between February and June, and at the Red Bluff Diversion Dam from March to mid-October (DFG 1997). Historically, the Sacramento River downstream of Shasta Dam was used by spring-run as a migration route to and from cooler tributary streams. After the construction of Keswick Dam in May 1942, Moffett (1947) estimated that 25,000 spring-run spawned in this area of the mainstem Sacramento River. From 1947 until 1956, estimates of spring-run abundance in the Sacramento River were based on redd counts and ranged from 27,000 to 4,000 (DFG 1998). No estimates were made from 1957 through 1968. Starting in 1969, spring-run estimates were based on counts made at Red Bluff Diversion Dam (RBDD) which included fish that were destined for Battle and Cottonwood Creeks. The RBDD data indicates a decline of 9 percent per year from 1966 to 1992. Since estimates of spring-run escapements are also separately generated for these drainages, some fish are "double counted" and no analysis has been performed to adjust the RBDD estimates to account strictly for the spawners to the mainstem Sacramento River. From 1991-1997, counts at RBDD have been below 800 spring-run and in 1997 had declined to 189 fish.

In the Feather River, hatchery returns averaged 858 fish in the 1967-1991 period with an increasing trend from an average of 790 in the first five years of the period to 1,386 fish in the last five years of the period (USBR 1997).

There has recently been evidence that spring-run are spawning in Clear Creek (DFG 1998). Following construction of Oroville Dam, the spring-run population has varied from an all-time low of 146 fish in 1967 (Menchen 1969) to a high of 6,833 in 1988 based on estimates generated according to the number of fish entering the Feather River fish hatchery. There is indication of spring-run and fall-run chinook salmon hybridization with resulting introgression in the Feather River, based on coded wire-tag information from hatchery returns (DFG 1998; Yoshiyama et al 1998).

During 1990 - 1996, the annual spring-run returns to Mill and Deer creeks collectively numbered around 330 - 1,620 fish. In Butte Creek, annual run sizes were 100 - 750 fish during 1990 - 1994, and 1,180 - 7,480 fish during 1995 - 1996 (Yoshiyama et al 1998). The spawning escapement estimate for Butte Creek was 3,529 - 3,679 during 1999, a decline from a high of 20,259 in 1998 (DFG 2000). The Deer Creek 1999 estimate of 1,591 fish is similar to the 1998 estimate of 1,879, and for Mill Creek is 560 fish, a slightly higher exception from the 1998 estimate of 424 fish (DFG 2000). For Butte, Mill and Deer creeks the 1999 cohort replacement rates range from 2.2 to 2.6 indicating an increasing abundance of spring-run chinook salmon for those creeks. Spawning redds of spring-run chinook salmon have also been found in Big Chico, Antelope, and Beegum creeks, and the Yuba River (DFG 1998). The level of possible hybridization with fall-run chinook in the Yuba River is unknown (SRBPP 2000).

Redd surveys of the spring-run spawning habitat in the mainstem have found little spawning in August or September when spring-run salmon have historically spawned (DFG 1998). Competition for spawning sites may result in later spawners' displacement of early spawner redds during nest construction. In addition, the lack of spatial isolation between spring-run and fall/late-fall runs of chinook salmon likely results in some hybridization between the two runs.

Central Valley spring-run chinook populations within the action area generally show a continuing population decline, an overall low population abundance, and fluctuating return rates (DFG 1998). These demographics for Central Valley spring-run chinook indicate the long-term viability of the ESU is at risk.

The action area is located within the critical habitat of Central Valley spring-run chinook. Critical habitat within the action area ranges from riverine habitat to estuarine areas. The essential elements of critical habitat in these areas are the water, substrate, and adjacent riparian areas.

B. Status of Critical Habitat Within the Action Area

The action area lies within designated critical habitat for the Sacramento River winter-run chinook salmon (58 FR 33212), the Central Valley steelhead (65 FR 7764), and the Central Valley spring-run chinook salmon (65 FR 7764).

The essential features of freshwater salmonid habitat within the action include: adequate substrate, water quality, water quantity, water temperature, water velocity, cover/shelter, food; riparian vegetation, space, and safe passage conditions. These features have been affected by human activities such as water management, flood control, agriculture, and urban development throughout the action area. Impacts to these features have led to salmonid population declines significant enough to warrant the listing of several salmonid species in the Central Valley of California.

Instream woody material (IWM) and shaded riverine aquatic (SRA) habitat is necessary for juvenile rearing, and paramount for the survival of fry and subyearlings (USFWS 2000). Overhanging vegetation provides shade, moderates water temperatures, and contributes to allochthonous materials and energy input into river productivity at all trophic levels Yoshiyama et al 1998). The increase of riprapping along the Sacramento River and tributaries has removed much IWM, and therefore areas of refugia providing food, cover, and shelter (USFWS 2000). Passage conditions affording safety from extreme water temperatures and flows, predation, and starvation have likewise been compromised with the removal of significant areas of SRA/riparian habitat.

High water quality and quantity are essential for survival, growth, reproduction, and migration of individuals dependent on riparian and aquatic habitats. Important water quality elements include flows adequate to support the migratory, rearing, and emergence needs of fish and other aquatic organisms. Desired flow conditions for salmonids include an annual abundance of cool, well-oxygenated water with low levels of suspended and deposited sediments or other pollutants that could limit primary production and/or invertebrate abundance and diversity.

Water temperature is one of the most important factors controlling early-life survival and growth of Pacific salmon, with direct implications to incubation, hatching, emergence and growth (USFWS 1999). Temperature also influences swimming performance, and increased vulnerability to predators and disease (USFWS 1999). Salmonids are exposed to increased water temperatures from late spring through early fall in the lower Sacramento River and San Joaquin River reaches and the Delta. These temperature increases are primarily caused by the loss of riparian shading, and by thermal inputs from municipal, industrial, and agricultural discharges.

To a great extent, streamflow volume and runoff patterns regulate the quality and quantity of habitat available to juvenile salmonids. Salmon and steelhead are adapted to seasonal changes in flow. Increased stream flows in the fall, winter and spring stimulate juvenile salmonid downstream migration, improve rearing habitat, and improve smolt survival to the ocean. Changes in runoff patterns from upstream reservoir storage to the Delta have adversely affected Central Valley salmonids, including winter-run chinook salmon, spring-run chinook salmon and steelhead, through reduced survival of juvenile fish.

Habitat Impacts in the Action Area

The Sacramento River basin been transformed from a meandering waterway lined with miles of riparian corridor, to a highly leveed system under varying degrees of control over riverine erosional processes and flooding. This process began about 150 years ago, when the Sacramento River was bordered by approximately 500,000 acres of riparian forest, extending up to 4-5 miles along each side of the river and encompassing at least one-half million acres. The river was free from restrictions of dams and diversions. Late summer flows were low in contrast to today's summer flows, probably averaging about 3,000 cubic ft per second (cfs). Dry-year flows may have dropped to as low as 1,000 cfs. Flows fluctuated widely, however, in response to winter rains, and sustained high flows occurred in the spring each year in response to snow melt (USFWS 2000).

The high winter and spring flows resulted in over-bank flooding, over extensive reaches of the valley floor covered by up to one-half million acres of dense riparian vegetation. Extensive swamps, marshes, and other diverse and expansive wetlands were also nourished by the regular flooding events (USFWS 2000).

Bank erosion and river meander, the underlying forces for most riverine ecological processes and functions, were unimpeded. Erosion was most active on the outsides of the numerous meander bends, where the highest velocities impinged directly on the earthen substrates. As one bank was eroded, the opposite bank experienced sediment accretion and riparian vegetation colonization. Some of the meanders became cut off from the river, forming oxbow lakes and other broad, diverse channel overflow areas. Erosion also resulted in the input of large volumes of woody debris of a broad range of sizes, types, and complexities into the river. The fish, wildlife, and riparian vegetation of the river were in a dynamic equilibrium, adjusted to, and dependent upon the cycle of erosion, deposition, and changing channel pattern as the river slowly swung back and forth across its meander belt. The ecological health and productivity of the river at any point in time was dependent on periodic rejuvenation associated with these natural processes and changes (USFWS 2000).

Gold mining, dam construction, water diversion, and hydraulic mining launched the Central Valley into the era of water manipulation and coincident habitat degradation. By 1979, riparian habitat along the Sacramento River diminished to 11,000-12,000 acres or about 2 percent of historic levels (McGill 1979). More recently, about 16,000 acres of remaining riparian vegetation has been reported (McGill 1987). The degradation and fragmentation of riparian habitat has resulted mainly from flood control and bank protection projects, together with the conversion of riparian land to agriculture (Jones and Stokes Associates 1993). In addition, alteration of the Sacramento River's natural flow regime following construction of Shasta Dam has impaired the regeneration of riparian vegetation. Historically, the seasonal flow patterns included high flood flows in the winter and spring with declining flows throughout the summer and early fall. As flows declined during the summer, the seeds from willows and cottonwood trees, deposited on the recently created sand bars, would germinate, sprout, and grow to maturity. The roots of these plants would follow the slowly receding water table, allowing the plants to become firmly established before the next rainy season.

With the completion of upstream reservoir storage projects throughout the Central Valley, the seasonal distribution of flows differs substantially from historical patterns. The magnitude and duration of peak flows during the winter and spring are reduced by water impoundment in upstream reservoirs. Instream flows during the summer and early fall months have increased over historic levels for deliveries of municipal and agricultural water supplies. Overall, water management now reduces natural variability by creating more uniform flows year-round. Current flood control practices require peak flood discharges to be held back and released over a period of weeks. Consequently, the mainstem of the river often remains too high and turbid to provide quality rearing habitat.

Hydropower and flood control dams of the CVP and SWP have permanently blocked or hindered salmonid access to historical spawning and rearing grounds. Much of the Sacramento River drainage basin has been lost as salmonid habitat due to migration barriers. Downstream effects of these dams include significant alteration of flow regimes, riparian functions and quality, and primary productivity of the stream. Diversion and storage of natural flows have altered the natural cycles by which juvenile and adult salmonids base their migrations and have also depleted river flows. Depleted flows have contributed to higher temperatures, lower dissolved oxygen levels, and decreased gravel and large woody debris recruitment. The result has been simplification and fragmentation of fish habitat in the Sacramento-San Joaquin river basins (Reeves and Sedell, 1992).

Increased sedimentation resulting from agricultural and urban practices within the Central Valley is a significant cause of salmonid habitat degradation. Sedimentation has adversely impacted salmonids during all freshwater life stages by clogging, or abrading gill surfaces; adhering to eggs; inducing behavioral modifications; burying eggs or alevins; scouring and filling pools and riffles; reducing primary productivity and photosynthetic activity; and affecting intergravel permeability and dissolved oxygen levels. Embedded substrates have reduced the production of juvenile salmonids and hindered the ability of some over-wintering juveniles to hide in the gravels during high flow events. Increased sedimentation has also been shown to increase water temperatures, thereby directly impacting incubating and rearing salmonids.

Land use activities associated with road construction, urban development, logging, mining, agriculture, and recreation have significantly altered fish habitat quantity and quality through alteration of streambank and channel morphology; alteration of ambient stream water temperatures; degradation of water quality; elimination of spawning and rearing habitat; fragmentation of available habitats; elimination of downstream recruitment of gravel and large woody debris; and removal of riparian vegetation resulting in increased streambank erosion. In addition, unscreened water diversions for agriculture and municipal use have adversely affected salmonids through direct entrainment of emigrating juveniles. Agricultural and harvesting practices have eliminated large trees and logs and other woody debris that would have been otherwise recruited to the stream channel. Consequently lost were the sources of large woody debris which contribute to pool formation and stream channel dynamics.

Diking, dredging, filling of wetlands, and reduction of freshwater flows through the rivers and estuary by more than half for irrigated agriculture and urban use have widely reduced fish habitat and resulted in extensive fish losses (Moyle et al. 1992; Nichols et al. 1986). In addition, for many native fishes, losses of flooded areas with submerged vegetation and natural earthern banks and levees is inextricably tied to population reductions (USFWS 2000).

Today, the river is controlled by dozens of dams on the main stem and tributaries, largely confined by levees, and overall, a mere remnant of the ecologically dynamic and complex system of the past (USFWS 2000). These changes have worked in concert to dramatically reduce the locations, frequencies, and durations of overbank flooding events which provide essential vegetated flood plain habitat for native fishes.

Bank protection, as typically practiced by the Corps under auspices of the SRBPP, has played a significant role in the loss of this essential riverine and flood plain habitat. Since its inception in 1963, SRBPP has implemented 152 miles of riprapping on the lower Sacramento River (USFWS 2000). To date, Phase II has placed 371,000 lf (70.3 miles) of riprap via incremental contracts, while 34,000 lf (6.3 miles) remains. The Corps is already engaged in preliminary discussions regarding Phase III. With construction of the remaining 6 miles of riprapping to be completed under existing SRBPP authority, the total amount of river bank protected under SRBPP authority in the 194-mile-long project reach extending upstream from Collinsville (RM 0.0) in the Sacramento-San Joaquin Delta (Delta), will increase from 35 percent (in 1987) to 41 percent (i.e., of 194 x 2=388 miles of banks). The SRBPP will then encompass riprapping on about 44 percent of bank in the lower 60 miles downstream of Sacramento (RMs 0-60), 39 percent in mid-river between Sacramento and Colusa (RMs 60-145), and 30 percent between Colusa and Chico Landing (RMs 145-194) (USFWS 2000).

Moreover, the SRBPP makes up only part of the total bank protection that has been completed within the project reach. Since 1963, riprapping has also been done by (a) the State, under its Delta Levees Subvention Program and other authorities; (b) various levee and reclamation districts; (c) private individuals; and (d) emergency (i.e., under the auspices of Public Law 84-99) levee repair actions of the Corps in concert with local agencies. The total post-1963 non-project bank protection has been estimated to be at least 16 miles. In addition, an unquantified amount of bank protection was placed within the project reach by various entities before 1963; until this amount is quantified, a reasonable estimate is that it is 15 percent (of completed SRBPP), or 24 miles. Thus, the estimated total embankment riprapped within the SRBPP since its inception is about 199 miles, or 51 percent of the 388 miles of river bank. The probable conservative nature of this estimate is illustrated by the Corps' estimate over 10 years ago that over 75 percent of the river bank downstream of Sacramento was already riprapped (USFWS 2000).

In addition to the SRBPP, another major Corps project "the Sacramento River, Chico Landing to Red Bluff Project" completed about 18 miles of riprapping within a 50-mile project reach, and another 15 miles of authorized work has been indefinitely delayed because of environmental concerns (USFWS 2000).

Of all previous bank protection applied along the lower Sacramento River, an unquantified amount has failed to some degree over time. Such failures range from minor displacements of rock armoring or earthen substrate to massive slippages of the levee structure. However, major failures are nearly always repaired. Minor failures, which may not be repaired, generally expose relatively minor amounts of earthen substrate. Many miles of major and minor riprapping failures were repaired during 1997-1999 by the Corps under auspices of Public Law 84-99, following significant recent flooding events. Therefore, the amount of levee erosion, which could contribute some ecological functioning at previously riprapped sites because of riprap failures, is assumed to be insignificant (USFWS 2000).

Typical bank protection involves both clearing (of vegetation) and grubbing (removing and/or adding soil and/or rock) to uniformly reshape the levee or bank, followed by riprapping the reshaped surface with river cobble stones (in the past) or quarry rock (today). Individual bank protection sites typically range from a few hundred to a few thousand linear feet in length. Such bank protection generally results in two levels of impacts to the environment: (1) site-level impacts which affect the basic physical habitat structure at individual bank protection sites, and

(2) reach-level impacts which are the cumulative impacts to ecosystem functions and processes that accrue from multiple bank protection sites within a given river reach (USFWS 2000). Revetted embankments result in loss of sinuosity and braiding, thereby reducing total area of habitat and degrading the remaining habitat by increasing mean velocity.

During the early years of the SRBPP, there was no compensatory mitigation provided for either site- or reach-level losses. Today, using the U.S. Fish and Wildlife Service's HEP (Habitat Evaluation Procedures) and various HSI (Habitat Suitability Index) models, including a model for Shaded Riverine Aquatic (SRA) Cover, the involved agencies are better quantifying and mitigating for the site-level impacts of bank protection. However, reach-level impacts are just beginning to be recognized and understood, and to date, there has been little, if any demonstrated success in providing specific compensatory mitigation for them (USFWS 2000). Reach-level impacts arise primarily from halting erosion and controlling riparian vegetation. Among the reach-level impacts which cause significant impacts to fish are: (a) reductions of new "accreted" habitats of various kinds, (b) changes to sediment and organic material storage and transport, (c) reductions of lower food-chain production, and (d) reduction in LWD. Recruitment is limited to any eventual, long-term tree mortality (i.e., insects, fire, disease, and decadence) and whatever abrasion and breakage may occur during high flows (USFWS 2000).

Rock armoring also greatly reduces, if not eliminates, the retention of LWD which is inputted from the lower Sacramento River's limited remaining recruitment sources (i.e., non-riprapped areas, either within the project reach or upstream). Riprapping creates a relatively clean, smooth, and featureless surface which diminishes the ability of LWD to become securely snagged and eventually well-anchored by sediment. Wood tends to become only temporarily snagged along riprap, and generally moves downstream with subsequent high flows. Habitat value and ecological functioning aspects are thus greatly reduced, because wood needs to remain in place to generate maximum values to fish and wildlife (USFWS 2000).

Clearly, the result for the lower Sacramento River is that new wood has not been replacing old, in-stream LWD that is gradually re-entrained and transported downstream during major flooding events. Thus, any equilibrium with respect to LWD, assuming one existed in the post-settlement, pre-riprapping era, has been upset and a downward trend for LWD has likely existed for at least several decades. Moreover, because LWD can be so long-lived under unimpaired conditions, often functioning for over a hundred years, the cumulative loss of LWD functioning as a result of bank protection is no doubt much larger than the 51 percent or so of river banks which have now been riprapped along the lower Sacramento River. Combined in a synergistic fashion, the loss of at least one-half of both LWD recruitment and LWD retention has likely resulted in a loss of two-thirds or more of LWD functioning (compared to pre-SRBPP conditions) overall for the lower Sacramento River. And within the lowermost river reach where riprapping is most extensive (over 75 percent of banks), the loss of LWD functioning may now exceed 90 percent (USFWS 2000).

Consequently, all or portions of the lower Sacramento River are likely now significantly debris-impoverished to the extent fish populations are being directly and negatively impacted. Abundant direct and indirect evidence exists of the impacts to juvenile salmonids from losses of LWD functioning (USFWS 2000).

In particular, Central Valley salmon and steelhead may be impacted by reductions of their adult migration corridor habitat, and juvenile rearing habitat, all of which could be reduced by associated losses of LWD, natural banks and SRA Cover (*see* USFWS 2000 for definition of this cover-type).

Juveniles probably rely almost exclusively on near-shore LWD and flooded herbaceous vegetation, and associated SRA Cover and natural bank areas, during drier years in which flood bypass flows are low or nonexistent. In addition, juvenile salmonids of the lower Sacramento River are likely being impacted by reductions, fragmentation, and general lack of connectedness of remaining near-shore, LWD-associated refugia areas. Any further incremental, cumulative losses of LWD and SRA cover functioning within any of the three distinct lower Sacramento River reaches (USFWS 2000) should therefore be considered a serious and unacceptable impact (USFWS 2000).

Numerous river segments can be observed, some many miles in length, where both opposing river banks are totally riprapped and completely devoid of either riparian vegetation (either woody or herbaceous) or any near-shore LWD and SRA Cover. Even if a mitigation strategy can be devised and implemented to begin to correct such refugia voids, it may require decades, if not hundreds of years, to overcome the serious fragmentation and general lack of input, retention, and functioning of LWD that exists today (USFWS 2000).

The Sacramento River is thus like most other large rivers of the West and Pacific Northwest. It has experienced the universal trend toward fragmentation and disconnection from important river processes and functions. While there are many sources for such disconnect, including dams, diversions, changes in flow regimes, and levees built too close to the river, modern bank riprapping efforts have clearly been an important cause of general ecological decline (USFWS 2000).

Maintenance of biotic diversity and natural community dynamics in streams and rivers of all sizes is directly related to the preservation of natural habitats and associated processes within the basin. Moreover, the greatest diversity and aerial extent of riverine refugia occur where there is a maximum interaction between floodplain and aquatic systems. In general, more complex units and channels are more likely to serve as refugia than less complex ones (USFWS 2000).

Another consequence of long-term bank protection has been the general simplification of fish habitat. Simplification includes a decrease in the range and variety of hydraulic conditions, reduction in the amount of LWD and other structural elements, and a decrease in the frequency and diversity of habitat units and substrate types. Such simplification has clearly been one of the aquatic cover, lack of woody material input, and a loss of streamside habitat complexity, within the Sacramento River basin. Positive correlations have been made between higher salmonid densities and bio-engineering bank stabilization projects, over traditional rip-rap designs (USFWS 2000). However, greater densities of fish were associated with natural riparian habitat. From these studies, it can be concluded that bio-engineering designs are an improvement over the standard practice of rip-rapping, but inferior to a naturally dynamic shaded riverine aquatic habitat. There is a scarcity of data for the Sacramento River Basin regarding the replacement of natural riparian habitat with bio-engineering designs. Much analysis needs to be done before this trend becomes the adopted standard in bank stabilization.

Urbanization

From 1990 to 2000, the population in the state of California grew by 13.6%, slightly ahead of the rest of the country (U.S. Census Bureau, 2000). Contracts 42E and 42F project sites lies within counties which have experienced an averaged population increase of 14.9% during this same period. Like many other states, California is experiencing urban sprawl replacement of its' natural areas and agricultural lands, and native vegetation or cultured crops are being supplanted with pavement and infrastructure. Water previously uptapped or diverted for irrigation is now supplying growing towns and cities, and there are a number of new outflows along the Sacramento River. Increased flood protection will occur in the near future to accommodate new development in the Sacramento River floodplain, as well as to maintain the current Federally-revetted embankments. It is expected that after the completion of Phase II of the SRBPP, the Corps will request its' re-authorization from Congress (Matt Davis, Corps, personal communication, March 15, 2001).

Restoration Efforts

Habitat restoration impacts in the Sacramento-San Joaquin river basins initiated under the CalFed Bay-Delta Program and the Central Valley Project Improvement Act's (CVPIA) Anadromous Fish Restoration Program (AFRP), in coordination with other Central Valley efforts, have implemented numerous habitat restoration actions that benefit Sacramento River winter-run chinook salmon, Central Valley steelhead, Central Valley spring-run chinook salmon, and their critical habitat. These restoration actions include the installation of fish screens, modification of barriers to improve fish passage, and habitat acquisition and restoration. The majority of these recent restoration actions address key factors for decline of these ESUs and emphasis has been placed in tributary drainages with high potential for winter-run chinook, steelhead and spring-run chinook production. Additional actions that are currently underway that benefit Sacramento River winter-run chinook, Central Valley steelhead and Central Valley spring-run chinook include new efforts to enhance fisheries monitoring and conservation actions to address artificial propagation.

V. EFFECTS OF THE ACTION

This section discusses the direct and indirect effects on Sacramento River winter-run chinook salmon, Central Valley spring-run chinook salmon, and Central Valley steelhead, and/or their designated critical habitat that are expected to result from the proposed action. Cumulative effects (effects of future State, local, or private actions on endangered and threatened species or critical habitat) are discussed separately.

Construction Impacts

The proposed project will involve the installation of 675 linear feet of riprap at RM 149.0 (Contract 42E); 1,050 linear feet at RM 85.6 (Contract 42F, Site 1); 230 linear feet at RM 123.5 (Contract 42F, Site 2); 395 linear feet at RM 130.0 (Contract 42F, Site 3); 395 linear feet at RM 130.8 (Contract 42F, Site 4); 690 linear feet at RM 164.0 (Contract 42F, Site 5); and up to 30,000 linear feet at additional sites (other Phase II actions). However, only 179 linear feet of riprap applied at Sites 1-4 will be new. The total project will affect ~2 % of the length of the Sacramento River. Construction activities involving in-water placement of riprap may cause rearing or migrating chinook salmon and steelhead to avoid habitat in the immediate vicinity of the project site. If small fish move into an area of higher predator concentration (e.g., deeper water), they may experience increased susceptibility to predation. In some cases, in-channel construction activities and equipment use may block or delay the migration of adult or juvenile salmonids (Knudsen et al. 1992, 1994). Construction activities adjacent to or in the flowing waters of the Sacramento River will disturb soils and the riverbed and could lead to increased river turbidity and sedimentation.

Placement of rip rap and removal of vegetation or instream woody material could lead to disturbance of soils and the riverbed, resulting in increased erosion, siltation, and sedimentation in the Sacramento River. Fuel spills or use of toxic compounds during project construction could release additional contaminants into the waterways. Degraded water quality may: (1) affect the ability of juvenile salmonids to feed; (2) block or delay migration of juvenile or adult salmonids; and, (3) cause juvenile salmonids to move into areas of higher predator density (Bisson and Bilby 1982; McLeay et al. 1984; Whitman et al. 1982). Release of contaminants could result in chronic or acute toxicity impacts to chinook salmon and steelhead. Food supply for juvenile salmonids also may be affected if sensitive aquatic invertebrate populations are adversely affected by degraded water quality. Effects of degraded water quality may extend downstream from construction sites. However, construction impacts to listed salmonids likely will be short-term and localized, and may be reduced by implementation of best management practices.

Direct Impacts to Habitat

The "properly functioning condition" (PFC) of site RM 149.0, the five sites of Contract 42F, and the remainder of the Sacramento River Bank Protection Project will be compromised as rearing habitat for juvenile salmonids, and as a corridor for migrating juveniles and adults. NMFS defines PFC as "the sustained presence of natural habitat-forming processes that are necessary for the long-term survival of threatened salmon and steelhead through the full range of environmental variation." Actions that affect salmon habitat may impair properly functioning habitat, appreciably reduce the functioning of already impaired habitat, or retard the long-term progress of impaired habitat toward PFC. In essence, the carrying capacity of the habitat will decrease with each SRA removal and rip-rap modification of the embankment. Restoring functional habitats depends largely on allowing natural processes to increase their ecological function, while at the same time removing adverse impacts of current practices.

The greatest impacts of the SRBPP on chinook salmon and steelhead would be expected to occur from long-term degradation and loss of designated critical habitat. These impacts range from those related to the simple removal of riparian vegetation to the indirect and complex effects of increased habitat fragmentation and changed erosional processes in the Sacramento River. The installation of riprap and removal of riparian vegetation or instream woody material due to the SRBPP will directly affect various aspects of fish habitat in the near-shore aquatic zone of the Sacramento River, including shade, physical structure, and water depth, velocity, and temperature. Site-specific analyses for Contracts 42E and 42F follow:

RM 149.0. The existing, moderately-sinuous, earthen shoreline, which is about 743 feet in length at MSW, would be reduced to 675 feet of uniform, hydraulically smooth riprap. About 6-12 pieces of existing instream wood, and a small amount of overhead woody plant cover on the hardpoint (which becomes flooded at higher flows), would be removed.

The five rock clusters placed atop the finished riprap would re-create at least some of the lost hydraulic diversity, variability, and cover (from bank sinuosity) removed along the near-shore zone. The 12-13 pieces of LWD anchored between the rock clusters would offset at least some of the lost instream woody debris value. The 0.50 acre of woody riparian vegetation planted in the finished riprap of the levee slope would, after 10-20 years, begin providing a small amount of overhead cover.

The amount and type of vegetation flooded during high-flow conditions would be affected. Construction of the launchable riprap feature would result in removal and clearing to bare ground of 0.26 acre of high-value, mature riparian forest with its associated woody and herbaceous understory. Construction of the bank fill and bank cut features would result in removal and clearing to bare ground of 0.69 acre of low-to-moderately dense herbaceous plants. Removal of the hard point during the bank cut construction would necessitate removal of an additional 0.01 acre of medium-sized riparian trees and shrubs, resulting in a loss of .96 acres of riparian/streamside vegetation.

Overall, for sites 1 through 4, and despite the fact that they were all previously riprapped, at least 179 linear feet of *new* riprap would be applied. In addition, some of the previously riprapped areas at these four sites where the rock has eroded away to bare ground over the past 6 decades, would be recovered with rock. Also, at three of the four sites (RMs 85.6, 123.5, and 130.8), the new rock would extend farther (by 4 to 12 feet) up the slope of the reshaped levee than now. Moreover, at Site 5 (RM 164.0), 690 lf of new riprap would be placed where none previously existed. Thus, overall, in addition to the minimum of 869 linear feet (179 feet for the three previously rocked sites, plus 690 feet at RM 164.0) of new riprapped shoreline, about 0.40 acre of new quarry rock would be replaced where previously placed cobble rock has eroded away.

RM 85.6 (Site 1). In contrast to RM 149.0 and despite the presence of cobble riprap installed in 1940, Site 1 has significant existing instream and overhead (above water at MSW) woody cover. The dominant type of instream cover in nearshore zones is medium- to large-sized, downed (from root undercutting) trees lying roughly parallel to the shoreline. These appear to be mostly trees that have fallen and remained at or very near their input point. Such large pieces of LWD generally exhibit the highest biological values and are most likely to remain stationary, thereby providing maximum biological functioning for longer periods, ranging from decades to hundreds of years (USFWS 2000).

Overhead cover is also present along the site in the form of large, mature trees rooted in the upper and middle portions of the bank, with smaller contributions provided by smaller trees and shrubs near the shoreline. Moderate diversity of woody growth is present, with at least 5 tree and 12 shrub species being represented. Instream wood and overhead cover are present along 72 percent and 82 percent, respectively, of the site length. The site has a low bank retreat rate, with estimated average long-term erosion of 0.0 feet/year and a short-term rate (here, and hereafter 1986-1997 average rate) of <1 foot/year (Ayres and Associates 2000).

The proposed action would result in the removal of all instream wood and most of the overhead woody cover along the bank. The overall volume, mass, size and complexity, of living woody vegetation flooded during high-flow conditions would decrease to near zero immediately following construction. This temporal loss would persist for 15 to 25 years while the replanted vegetation gained size and density. After 15 to 25 years, and depending on revegetation success and growth rates, there might then be more flooded woody vegetation during high-flow conditions than now. These values would remain quite low for at least several years, but may gradually increase as the replanted vegetation gains size and density. The loss of habitat cover and complexity could result in permanent loss of LWD.

It is unknown if the vegetation planted in the riprap, after it gained sufficient size (i.e., after 10 to 20 years), would be successful in snagging and retaining the most biologically significant large pieces of LWD contributed from upstream areas. The proposed project's elimination of the earthen substrate will impede the retention of trees, which embedded themselves in soft sediments during the recession of flood waters. Also, it is unknown whether the other biological functions of wood impinged in soft banks, such as sediment and organic matter trapping and retention, could be achieved by wood trapped along the quarry rock surface. Wood needs to be in contact with soft bottoms or banks for optimum biological functioning. Therefore, it is unlikely that trees growing in rock, even if they survive, will trap and retain fully functioning new wood from upstream sources, and the Corps' reliance upon this as a conservation measure would constitute an experimental measure that presently has unproven utility.

Rock cluster/LWD features, scalloped bank/LWD features or multi-level vegetated benches are likewise considered to be experimental in nature and likely to place risk on listed species. The possibility that monitoring might reveal that biological function has been irretrievably lost with such experimental conservation measures requires that proven or low-risk, offsite conservation measures be used to offset the adverse effects of the proposed action.

Refugia components would be adversely affected, as at RM 149.0. The only difference from RM 149.0 is that at Site 1, impacts on refugia components would be lesser in magnitude, because most of the site is already riprapped and the rate of erosion is much smaller than at RM 149.0. Nevertheless, because of the smoothly reshaped and refinished riprap surface, velocities along the bank would be increased and made more homogeneous (USFWS 2000). This would create an adverse effect on refugia characteristics and feeding values for many juvenile fishes, including salmonids (USFWS 2000). The proposed action would, as described for RM 149.0, reduce LWD input to the river over discontinuous portions of the 1,050 lf of bank at the site. This would create indirect effects from the site location at RM 85.6 all the way down river to the Delta. There is no basis for a conclusion that this particular intended function would be replaced to even a minimal degree by the vegetation planted in the riprap. Current wood input from site 1 is clearly in the form of whole, complex pieces of wood (whole trees with root ball) introduced periodically due to root undercutting during episodic, high-flow events. Future wood input from the site would, just as at RM 149.0, be in the form of small, simple pieces introduced in very small quantities due to minimal breakage and abrasion during high flows. Moreover, such minimal input would only occur after 2 to 4 decades, when the woody plants had attained considerable size and density. In addition, it is well known that such small wood pieces have both very low biological values and low ability to be retained in place as they migrate downstream within the river system (USFWS 2000).

Overall, the most significant biological value losses at this site would be (a) the removal of significant existing large pieces of LWD, which are presently relatively stable and have likely been functioning in place for many years; (b) the reduction of future LWD input to the river from the site, which would, in turn, create indirect adverse effects (i.e., loss of future LWD functioning) from the RM 85.6 site all the way downstream to the Delta; (c) a temporal reduction for at least several years in the amount of flooded vegetation present during high-flow conditions; and (d) significant temporal losses, and long-term losses as well, in important refugia components, including microhabitat water temperatures, from the site downstream to the Delta.

RM 123.5 (Site 2). Site 2, a non-natural site, has low SRA cover values because of the absence of any overhead and instream woody cover. The exposed and submerged portions of the bank are steep and covered with cobble and boulder revetment partially imbedded in fine sediments. Because of the combination of fine sediments, boulders and cobble the area may function as cover and foraging habitat for some native fishes, including salmonids, but vegetative cover is lacking. One LWD piece was in place about 20 feet from shore when the site was surveyed by the Corps' consultant on May 13, 1999. A small berm is present along the length of the site, but contains only annual grass vegetation, and is quite high above MSW, thus providing little, if any, vegetated floodplain habitat during high-flow conditions.

The site has an estimated average long-term erosion rate of about 0.1 foot/year, and a short-term rate described only as "low." The selected alternative for the site is the "bank fill rock slope" approach, which would include a toe trench, toe rock, and replanting of the finished riprap with woody riparian vegetation.

Small incremental losses of fisheries and aquatic habitat value would occur from removal of the one LWD piece, riprapping areas where original rock has washed away, and extending the riprap 5-10 feet farther up the bank. The replanted vegetation in the rock would function over a relatively wide range of above-MSW flow conditions, however, and may partially offset adverse effects to salmonids. Additional mitigation features, such as the rock cluster/anchored LWD feature might provide some small to moderate habitat benefits facilitating these species' recovery.

RM 130.0 (Site 3). This non-natural site has only ruderal, herbaceous plant coverage on the upper bank slope. The middle and lower banks are covered with bare rock and sandy revetment. There is no woody vegetation along the bank or in the water along the near-shore area.

This site, on the outside of a sharp bend, is subject to high velocities and scour associated with bendway hydraulics and active channel migration. A 25-foot-deep scour hole recently existed along about 50 feet of bank length on the downstream end of the site, which was causing bank steepening, and which was subsequently recently repaired under unknown (but likely non-Federal) authority. The site's estimated average erosion rates are 0.5 foot/year and 1.0 foot/year, short- and long-term, respectively.

The selected alternative is the "toe rock" option, which would include a toe trench and replanting of the existing riprap with woody riparian vegetation. The new toe rock would not extend as far up the levee slope as the existing rock. Also, since virtually all of the existing site already has the rock coverage applied earlier, no presently barren areas would have to be recovered. The woody vegetation planted in the rock could provide some small to moderate benefit towards species' recovery.

RM 130.8 (Site 4). This is another non-natural site on the outside of a sharp bend in the river. It is also subject to high velocities, scour, and bendway hydraulics. The levee slope and bank are over-steepened with active erosion of the middle and lower levee slope. A small berm is present along most of the site, but it is over 20 vertical feet above MSW. Estimated annual erosion rates are 0.8-1.9 feet/year long-term and 0.8-2.0 feet/year over the short-term (Ayres and Associates 2000).

A narrow, continuous band of large trees with sparse understory is present along the upper bank and berm area. A total of six tree and eight shrub species are represented along the site. Along the lower bank there is no woody vegetation, only riprap and intermittent bare areas where the riprap has eroded away. Instream woody material is present along 67 percent of the site in the form of several logs and exposed rootwads of several large cottonwoods.

The selected alternative at the site is the "bank fill rock slope and toe rock" method, which would include a toe trench and woody riparian vegetation replanting in the finished riprap. Construction would result in removal of all of the instream woody material and most of the large trees along the bank. Rock would be extended about 7-12 feet farther up the levee slope than now and currently bare areas would be recovered with riprap. Adverse impacts to the aquatic environment, and thus to juvenile salmonids, would be essentially the same as for the proposed action at site 1.

RM 164.0 (Site 5). This site adjacent to the town of Princeton is a high-biological-value site with earthen banks and no previous riprap. It is located in a reach of the lower Sacramento River heavily characterized by active meander bends, oxbow lakes, and frequently-inundated floodplain habitat. It is approximately 3 miles downstream from the Packer Lake and Codora Units of the Sacramento River National Wildlife Refuge Complex.

Various engineering and environmental surveys have recently revealed the following about the existing, earthen banks along the site: considerable near-shore diversity and variability exists due to bankline sinuosity; steep, intermittent, mass block slippages and failure areas have occurred along the site; and there are abundant smaller erosion pockets and holes along the site. Twelve of 14 transects evaluated perpendicular to the MSW shoreline within the site limits have instream woody material. This woody material includes typical LWD pieces composed of large tree trunks, branches, and exposed root balls of downed trees. Many of the wood pieces are well-anchored, and have thus likely been in place and functioning for many years. Instream woody material and overhead cover occur along about 86 percent and 36 percent, respectively, of the site length. Overhead cover is provided by both standing and downed trees along the site. Eight tree species and seven shrub species are represented. Only one of 14 transects in the project reach was devoid of both instream and overhead cover. A berm area exists along the top of the site; this berm and much of the middle and lower bank slopes are covered largely with herbaceous vegetation, mainly various grasses. The high-value attributes of the site extend contiguously for several hundred feet both upstream and downstream from the site.

Since 1935, actual bank retreat at the site has been minimal. In fact, the long-term erosion rate is described by the Corps' engineering consultant as being "accretion," and the short-term erosion rate is estimated at 0.5 foot/year. Nonetheless, the site is described as being subject to high velocities, scour, and the possibility of large mass failures, due to the "moderately cohesive bank and toe materials"(Ayres and Associates 2000). The selected alternative for the site is the "bank fill rock slope" alternative, which would include a toe trench, toe rock, and replanting of woody riparian vegetation in disturbed areas and along the finished riprap.

The selected alternative would result in removal of all of the instream wood along the shoreline and most of the trees and shrubs along the bank. Riprap would be placed atop the reshaped levee from the toe trench to a point about 25 feet up the levee slope from MSW. About 775 feet of existing MSW shoreline would be converted to a uniform 690 feet of riprapped shoreline.

The various environmental effects of the action would be the same as described above for RM 149.0L. However, the magnitude of overall adverse effects to salmonids would be even greater at site 5 than at RM 149.0, because site 5: (1) has abundant existing, high-value, instream and overhead woody cover, which would accrue greater temporal losses of habitat values associated with its removal; (2) has high-value existing refugia characteristics, including possible near-shore, microhabitat water temperature modulation value; (3) is longer than the proposed RM 149.0 site (existing 775 feet versus 743 feet; finished, 690 feet versus 675 feet); (4) is farther upstream, and thus would have greater indirect effects (i.e., future LWD input) extending downstream to the Delta; and (5) has no rock clusters or anchored LWD features, or similar features, proposed in the construction.

As described for other sites, the proposed action would fail to negate all of the adverse effects that would accrue on-site and extend downstream to the Delta. At a minimum and just as for RM 149.0, there would still be a significant reduction of future LWD input from the site into the river. This in turn would have adverse effects on the listed species' habitats, both at the site, and extending downstream to the Delta. Because of the known dynamics of LWD in rivers, these adverse effects could extend for decades or longer, even if a major ecosystem restoration effort were to eventually be implemented along the lower Sacramento River (Service 2000). These adverse effects fragment the population, reduce habitat suitable for reproduction, rearing, and foraging, and are likely to increase predation on all life stages.

Implementation of Contract 42F will result in the conversion of 775 lf of earthen banks to riprap, with an associated loss of LWD input and retention. In the absence of a setback levee approach, project-life losses of habitat (temporal and net), even under the most optimistic, model-driven outcome, would require the application of proven, offsite conservation measures to offset these adverse effects.

Direct Impacts to Listed Species

Riparian vegetation greatly influences the biological and physical processes that provide freshwater habitat for salmonids. These processes include shade and cover, water quality and flow routing, the aquatic food web, sediment routing and composition, stream channel bedform and stability, and linkages to the floodplain (USFWS 2000). Nearshore areas provide valuable attributes for rearing and migrating juvenile salmonids, including: (1) banks composed of natural, eroding substrates supporting riparian vegetation that either overhangs or protrudes into the water; (2) a source of woody debris, natural detritus such as leaves, logs, branches and roots; and (3) variable water velocities, depths and flows which provide refugia. In-water cover, from downed branches or trees or overhanging vegetation and irregular banks, enhances the diversity of the stream habitat and provides juvenile salmonids opportunities for feeding and protection from predators.

Abundance of juvenile salmonids in nearshore habitat is positively correlated with the amount of wood cover (Beamer and Henderson, 1998). Wood cover in hydromodified banks has a lower than average chinook abundance when compared to natural banks with the same amount of wood cover. The greater the complexity (e.g., rootwads, debris piles), the more preferred by juvenile salmonids. The removal of wood cover combined with the smoothly reshaped and refinished riprap surface of SRBPP sites would be expected to result in increased homogeneous water velocities (USFWS 2000). This would create an adverse effect on refugia characteristics and feeding values for many juvenile fishes, including salmonids (USFWS 2000). With a potential decrease of refugia in designated critical habitat along the Sacramento River, there will be increased competition for these sites among all salmonids as refugia temporarily exceed carrying capacity. The increased density of small fish in remaining refugia may also increase predation.

An additional important refugia-related impact would be elevation of nearshore water temperature. This would occur as a result of the significant temporal loss for many years of moderately large amounts of both instream and overhead woody cover. The reduction in tree shade canopy along with the initial and continued loss of trees adjacent to riparian zones can increase water temperatures by 11.7 F to 18 F (Reynolds et al.1993, cited in NMFS 1996). Higher temperatures may slow fish growth, produce physical abnormalities, decrease survival and viability, increase incidence of disease, and cause mortality. Salmon and steelhead are dependent upon a cold-water temperature regime for the freshwater portion of their lifecycle. Additional removal of riparian vegetation along an already SRA-deficient Sacramento River could be detrimental to salmonid migration, spawning, incubation, rearing, emigration, and smoltification. Temperature increases can shift ecological relationships allowing fish species such as sunfish (centrarchid spp.), suckers (catostomid spp.), dace, pikeminnows and shiners (cyprinid spp.), to become numerically dominant in the ecosystem over salmonids.

Indirect Impacts to Habitat and Listed Species

The proposed action is designed to halt erosion along the site, thus eliminating the input of LWD in the form of shrubs and trees resulting from undercutting banks. Basic habitat renewal processes, such as meander migration, would be affected. While the reduction of LWD input at the site would appear, in itself, to only represent a small loss, it must be related to the small fraction of remaining SRA. Past bank changes have reduced the Sacramento River LWD by 67 - 90%.

Reduction or elimination of large woody debris may influence stream morphology by affecting pool formation, channel pattern and position, and channel geometry. Fish may not find holding areas, especially in drought conditions. The reduced input of LWD would have adverse effects on the listed species' habitats, both at the site, and extending downstream to the Delta. Because of the known dynamics of LWD in rivers, these adverse effects could extend for decades or longer, even if a major ecosystem restoration effort were to eventually be implemented along the lower Sacramento River (USFWS 2000).

The proposed action would convert existing earthern areas, which are better at snagging and retaining LWD than riprapped areas (USFWS 2000), to riprap. It is unknown whether the vegetation planted in the riprap would, after it gained sufficient size (i.e., after 10-20 years), be successful in snagging and retaining the most biologically significant large pieces of LWD inputted from upstream areas. Also, it is unknown whether the other biological functions of wood impinged in soft banks, such as sediment and organic matter trapping and retention, could be achieved by wood trapped along the quarry rock surface.

There would be significant unknowns related to the rock clusters, anchored LWD, and replanted riprap features of the proposed action. Other recent studies of juvenile salmonds have generally shown such mitigative features to be less than fully successful in restoring fish densities (USFWS 2000). The rock clusters, anchored LWD, and replantings in riprap, must be considered experimental features that would place additional risk on juvenile salmonids. In particular, it is unknown whether these features could and would be maintained in their finished, engineered condition over the full 50-year life of the project. In addition, their relative degree of biological functioning and the time needed to achieve functioning compared to natural river bank conditions are unknown.

The Corps contends that the new woody riparian vegetation that would be established in the finished riprap and on the berm area would, over time, and through natural growth, breakage, and decadence, contribute instream woody material to the river system. Based on the extensive literature review of LWD by USFWS (2000), the biological value to fisheries of such future input, consisting of typically small amounts of wood, would be extremely low relative to existing, no-project LWD input and values. Moreover, we conclude that there would be a significant, nearly complete, temporal loss of wood input to the river for at least 2-4 decades, while the replanted woody vegetation grew to sufficient size to allow for minimal breakage during high flows, or decadence and related breakage. There is currently no evidence to demonstrate that woody vegetation growing in riprap will significantly contribute to high-value LWD in the lower Sacramento River system.

Such reduction of LWD input by the proposed action would eventually affect biological conditions all the way downstream to the Delta. This is based on the movement of LWD input that historically occurred gradually, perhaps over decades or even hundreds of years, downstream to new sites. This process would be interrupted, resulting in a starved system. This would be particularly significant for the lower river downstream of Verona, where loss of SRA from previous riprapping may now exceed 90 percent (USFWS 2000).

Moreover, one of the key functions of LWD naturally anchored along earthen river banks and bottoms, is trapping and retention of sediments and organic matter, which in turn have roles in providing habitat, cover, and food for fishes (USFWS 2000). It has never been demonstrated that either rock clusters or anchored LWD (or the instream wood, if any, such features might snag), are capable of providing sediment and organic material trapping and storage characteristics along riprapped banks the same as would occur along earthen banks. In fact, it is rare to see any significant accumulations of sediment and/or organic matter along riprapped banks of the lower Sacramento River, either with or without an association with LWD. This is because the increased, smoother, more homogeneous velocities occurring along riprap compared to natural, eroding, earthen banks and levees generally prevent sediment and organic matter retention (USFWS 2000).

VI. CUMULATIVE EFFECTS

Cumulative effects include the effects of future State, tribal, local, or private actions that are reasonably certain to occur in the action area considered in this biological opinion. Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the ESA.

Non-Federal Actions

Non-Federal actions that may affect the action area include State angling regulation changes, voluntary State or private sponsored habitat restoration activities, State hatchery practices, agricultural practices, water withdrawals/diversions, increased population growth, mining activities, and urbanization. State angling regulations are generally moving towards greater restrictions on sport fishing to protect listed fish species. Habitat restoration projects may have short-term negative effects associated with in-water construction work, but these effects are temporary, localized, and the outcome is a benefit to these listed species. Increased water turbidity levels for prolonged periods of time could adversely affect the ability of young salmonids to feed effectively, resulting in reduced growth and survival. Turbidity may cause harm, injury, or mortality to juvenile chinook or steelhead in the vicinity and downstream of the project area. High turbidity concentration can cause fish mortality, reduce fish feeding efficiency and decrease food availability (Berg and Northcote 1985, McLeay et al. 1987, NMFS 1996). State hatchery practices may have negative effects on naturally produced salmonids through genetic introgression, competition, and disease transmission resulting from hatchery introductions. Farming activities within or adjacent to the action area may have negative effects on Sacramento River water quality due to runoff laden with agricultural chemicals. Water withdrawals/diversions may result in entrainment of individuals into unscreened or improperly screened diversions, and may result in depleted river flows that are necessary for migration, spawning, rearing, flushing of sediment from spawning gravels, gravel recruitment and transport of large woody debris. Future urban development may adversely affect water quality, riparian function, and stream productivity. Future land conservation and habitat restoration activities are anticipated to offset many of the adverse effects associated with these non-Federal actions.

Rip-Rapping

Beginning in the 1930s and 1940s, and continuing until today, non-Federal riprapping projects have also been installed along the river system by private individuals. Data on the location and extent of such non-Federal riprapping is currently unavailable (USFWS 2000).

Without knowledge of the amounts and locations of all non-Federal riprap placed in the past, informed projections of future cumulative non-Federal riprap likely for the lower Sacramento River system are somewhat problematic. Nevertheless, it is clear that non-Federal riprapping is continuing today and is likely to continue in the future. Riprap is relatively inexpensive and effective at controlling erosion compared to other bank stabilization techniques (Schmetterling et al. 2001). For example, a considerable amount of new, privately applied riprap can be seen in association with new home development along the Garden Highway on the east bank of the Sacramento River just upstream of Sacramento, roughly between RM 60 and RM 70.

A reasonable projection of future non-Federal riprapping, until better estimates become available from the Corps' Comprehensive Study or through other venues, can be made using past data and a few key assumptions. First, it is known that since 1963, about 152 miles of riprap have been placed along the lower Sacramento River system by the SRBPP alone (USFWS 2000). Assuming non-Federal riprapping as 10 percent of the SRBPP amount over the same 37-year period, the non-Federal total is 15 miles or 2,140 linear feet/year since 1963. Furthermore, assuming that non-Federal riprapping has, like SRBPP, now slowed to a much lower annual rate than in the past (due to overall gradually improving levee conditions), a reasonable estimate is that non-federal riprapping is currently averaging only about 50 percent of the former 2,140 feet/year, or 1,070 feet/year. Thus, annual non-federal riprap work totaling a similar order of magnitude to the present RM 149.0 site proposed under SRBPP authority is likely occurring now and will continue to occur well into the foreseeable future, as new erosion trouble spots develop along the river or as new private developments necessitating riprap occur on the river's banks.

The extent to which riprap affects stream function and salmonid populations is not well studied. Such non-Federal riprapping has the same, if not greater, impacts to ecosystems processes and functions, and therefore to salmonids, as the ongoing SRBPP riprapping. Since set-back levees, which allow avoidance of all aquatic and fisheries impacts, are not being utilized by non-Federal interests, temporal and spatial losses of submerged, vegetated areas, including SRA cover and LWD, are both common and significant. As with SRBPP riprapping, non-Federal riprapping poses threats as described above salmon and steelhead adult spawning needs; adult pre-spawning foraging needs; juvenile rearing and perhaps migration needs, and general refugia needs.

VII. SUMMARY

The survival and eventual recovery of Sacramento River winter-run chinook salmon, Central Valley steelhead and Central Valley spring-run chinook salmon are dependent on maintenance and restoration of high-quality habitat along mainstem rivers and tributaries.

The proposed projects, minus proven conservation measures, would adversely affect primary constituent elements of Sacramento River winter-run chinook salmon, Central Valley steelhead and Central Valley spring-run chinook salmon critical habitat, that is, juvenile rearing habitat; and adult and juvenile migration.

For these reasons, NMFS believes that continued application of riprap along the lower Sacramento River must include a concurrent program to restore SRA and floodplain habitat through proven conservation measures including removal of riprap from embankments and restoration of lands currently lacking lateral channel migration potential, and/or implementation of setback levees. All sites must include high potential for resumption of natural erosive forces and lateral channel migration, and must restore a significant degree of fluvial process to the river. SRA needs to be re-established and maintained along the riverine corridor to promote refuge for salmonid rearing and migration. IWM, which provides nutrient input and serves as substrate for riverine food chains, must be supplied to an increasingly wood-impoverished river.

The proposed project at RM 149.0 includes experimental conservation measures within its design to offset the incremental loss of river function. The removal of earthen substrate by bank-cut reconstruction and the installation of quarry rock will be partially off-set by vegetation plantings on-site for future SRA. Further minimization of adverse impacts include restoration of some hydraulic complexity and diversity to provide cover and help trap sediment and organic material. This will be implemented with the establishment of rock clusters intervening with anchored large woody debris. More vegetation plantings will replace those removed during project preparation and execution. Conservation measures are necessary for the immediate and continuing loss of SRA and IWM, and the reduction in salmonid habitat value at RM 149.0. The IWG will find an area off-site from RM 149.0 to compensate for the abrupt cessation of fluvial functioning at that location, with emphasis on locating a suitable site for a set-back levee. Other proven conservation measures will be explored as required.

Temporal delays of any agreed-upon restoration project will lead to escalating compensation ratios. With the incorporation of proven conservation measures into the project description, it is NMFS' opinion that the adverse effects caused by the implementation of the experimental design at RM 149.0 will be temporary, and that the overall project will lead to an improved environmental baseline for the listed salmonids, aiding in their recovery.

VIII. CONCLUSION

After reviewing the best scientific and commercial information; the current status' of Sacramento River winter-run chinook salmon, Central Valley steelhead, and Central Valley spring-run chinook salmon, and designated critical habitat; the environmental baseline for the action area; the effects of the proposed action at RM 149.0; and the Corps' commitment to undertake proven conservation measures including set-back levees, removal of riprap from and restoration of lands that currently lack lateral channel migration potential, including inter-levee terraces and potentially-eroding cut-banks; it is NMFS's biological opinion that the proposed Contract 42E (RM 149.0 and its off-site measure) increment of the SRBPP is not likely to jeopardize the continued existence of the endangered Sacramento River winter-run chinook salmon, threatened Central Valley steelhead or threatened Central Valley spring-run chinook salmon, or result in the destruction or adverse modification of their critical habitats.

The conclusion of non-jeopardy on Contract 42E at RM 149.0 absolutely hinges upon incorporation of proven conservation measures into the project description to offset adverse impacts. To determine and implement the conservation action, the Corps will convene an IWG which will design and ensure construction of an off-site conservation area that restores the fluvial process lost to the riprapping of RM 149.0.

Similarly for Contract 42F, NMFS believes that implementation of the proven conservation measures would adequately avoid, minimize and mitigate adverse effects to the Sacramento River winter-run chinook salmon, Central Valley steelhead, and Central Valley spring-run chinook salmon and designated critical habitat, and consequently would avoid violation of section 7(a)(2). However, implementation of the separate components of Contract 42F (RMs 85.6, 123.5, 130.0, 130.8, and 164.0) will occur incrementally as each subsequent formal consultation is completed.

IX. INCIDENTAL TAKE STATEMENT

Section 9(a)(1) of the Act and Federal regulation pursuant to section 4(d) of the Act prohibit the take of endangered and threatened fish and wildlife species without special exemption. Take is defined as harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. NMFS further defines harm to include any act which actually kills, or injures fish or wildlife and emphasizes that such acts may include significant habitat modification or degradation that significantly impairs essential behavioral patterns, including breeding, spawning, rearing, migration, feeding or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered to be prohibited taking under the Act provided that such taking is in compliance with this Incidental Take Statement.

The measures described below are non-discretionary, and must be implemented by the Corps so that they become binding conditions of any grant or permit issued to the applicant, as appropriate, in order for the exemption in section 7(o)(2) to apply. The Corps has a continuing duty to regulate the activity covered by this incidental take statement. If the Corps (1) fails to adhere to the terms and conditions of the incidental take statement through enforceable terms that are added to the permit or grant document, and/or (2) fails to retain oversight to ensure compliance with these terms and conditions, the protective coverage of section 7(o)(2) may lapse. In order to monitor the impact of incidental take, the Corps must report the progress of the action and its impact on the species to NMFS as specified in this incidental take statement (50 CFR 402.14(i)(3)).

A. Amount or Extent of Take

NMFS anticipates incidental take of Sacramento River winter-run chinook salmon, Central Valley steelhead, and Central Valley spring-run chinook salmon, primarily through impairment of essential behavior patterns as a result of reductions in the quality or quantity of their habitat. In addition, NMFS anticipates that some listed salmonids may be killed, injured, or harassed during the construction and implementation of this project.

NMFS anticipates that any take of Sacramento River winter-run chinook salmon, Central Valley steelhead, and Central Valley spring-run chinook salmon will be difficult to detect and quantify for a number of reasons. It is not possible to provide objective estimates of the numbers of Sacramento River winter-run chinook salmon, Central Valley steelhead and Central Valley spring-run chinook salmon that will be harassed, harmed, or killed during construction, or afterwards. In such instances where take is otherwise difficult to detect and impossible to quantify, NMFS shall estimate take in terms of some aspect of the species' habitat that may be diminished or removed by the proposed action and would result in harmful effects to individuals of the species.

Accordingly, NMFS is quantifying take of Sacramento River winter-run chinook salmon, Central Valley steelhead and Central Valley spring-run chinook salmon incidental to SRBPP-related projects as the number of linear feet of natural, earthen river bank or levee shoreline that has SRA cover, shallow, inundated vegetation, and/or LWD, and would become less suitable or unsuitable for the species as a result of being completely reshaped and then covered with a layer of quarry rock riprap. It is anticipated that take would be primarily in the form of harm to the species through modification or degradation of their rearing habitat refugia and migration corridor.

NMFS estimates that take would amount to the 743 lf of impact for at least 50 years, due to implementation of the experimental design at RM 149.0. Additional take associated with implementation of the construction, and maintenance and monitoring program for RM 149.0 authorizes a qualified individual or individuals, subject to the prior, written approval of NMFS, to incidentally take 5 Sacramento River winter-run chinook salmon, and up to a combined 50

Central Valley steelhead and Central Valley spring-run chinook salmon within the 2001 calendar year construction season for emergency salvage or recovery, or in the event of injury or death of Sacramento River winter-run chinook salmon, Central Valley steelhead, and Central Valley spring-run chinook salmon.

The incidental take associated with implementation of the setback levee conservation measure cannot be determined absent a final design for the site. This issue will be resolved once the setback levee has been designed, proposed, and subject to review by the IWG.

The incidental take associated with sites RMs 26.9, 43.1, 43.3, 85.6, 123.5, 130.0, 130.8, and 164.0 will be definitively determined during the corresponding re-initiated consultation(s). Should the Corps pursue additional Phase II incremental actions, incidental take will be addressed via programmatic formal consultation.

B. Effect of the Take

NMFS has determined that the above level of take is not likely to jeopardize Sacramento River winter-run chinook salmon, Central Valley steelhead, or Central Valley spring-run chinook salmon. The effect of this action in the proposed riprapped river areas will consist of fish behavior modification, temporary loss of habitat value, and potential death or injury of juvenile Sacramento River winter-run chinook salmon, Central Valley steelhead, or Central Valley spring-run chinook salmon.

C. Reasonable and Prudent Measures

NMFS recommends the RPMs as necessary and appropriate to minimize the likelihood of take on the Sacramento River winter-run chinook salmon, Central Valley steelhead, or Central Valley spring-run chinook salmon through implementation of the RPA:

1. Minimize the impacts on normal behavioral patterns of the Sacramento River winter-run chinook salmon, Central Valley steelhead, and Central Valley spring-run chinook salmon including, but not limited to, feeding, breeding, or sheltering.

2. Minimize effects of habitat loss due to the placement of rock riprap.

3. Maintain, monitor, and adaptively manage all conservation measures throughout the life of the project to ensure their effectiveness.

4. Ensure that all vegetation planted in finished riprap slopes, rock clusters, and anchored LWD, and multi-level, vegetated benches, all of which would constitute experimental, untested, and unproven mitigation elements, are successfully maintained over the life of the project, and are successfully performing their intended biological functions.

D. Terms and Conditions

To be exempt from the prohibitions of section 9 of the Act, the Corps must comply with the following terms and conditions, which implement the RPM described above:

1 The Corps shall, within 12 months of the onset of construction for each individual site within Contracts 42E and 42F, submit a detailed operations and maintenance plan for the bank protection and conservation measures found at all new sites constructed by the SRBPP. The operation, and maintenance plan shall also be designed such that the riparian vegetation, rock clusters, and anchored LWD are maintained and, pending the results of monitoring, are adaptively managed (modified) to ensure their mitigative value. If mitigative technologies are found to enhance habitat values for listed fish, they will be considered for wider application to other eroding sites. Should anchored LWD features be demonstrated to be harmful to listed species, NMFS will consider allowing maintenance practices to lapse.

1. The Corps shall, within 12 months of the on-set of construction of the first site within Contracts 42E and 42F, submit a detailed monitoring plan for NMFS to review and approve. Once approved, this monitoring plan shall then be incorporated into the above operations and maintenance manuals. Monitoring is necessary to ensure that the rock cluster/LWD structure is functioning in a manner that was predicted in the Habitat Evaluation Procedure (HEP) model, to possibly enhance habitat value and partially offsets the reduction in LWD input from the riprapped banks and the temporal loss of LWD input from the revegetated high bench. Monitoring is also required to determine the adverse effects associated with the loss of river function and increased habitat fragmentation associated with the project. The riparian vegetation, rock clusters, and anchored LWD shall be monitored to evaluate the sites' performance as designed and predicted by the HEP model. The Corps and local sponsor shall submit a yearly report to NMFS by December 31 of each year. This HEP monitoring is to be conducted until such time that the results of HEP modeling can be confirmed or rejected.

2. The Corps shall develop, with the assistance of the IWG, and the ultimate approval of NMFS, USFWS, and CDFG, a fisheries and aquatic ecosystem monitoring plan. Aquatic monitoring is necessary to ensure that the experimental rock cluster/LWD structure is functioning in a manner that enhances habitat value and partially offsets the reduction in LWD input from the riprapped banks and the temporal loss of LWD input from the revegetated benches. Monitoring is also required to determine the adverse effects associated with the loss of river function and increased habitat fragmentation associated with the project. Monitoring will also evaluate the effectiveness of restoration measures that encourage natural fluvial function (i.e. set-back levees, restoration of eroding banks, etc.). The results of monitoring will be used to develop future minimization measures and conservation ratios, and will help determine if mitigative features require long-term maintenance or must be modified to reduce unforseen adverse impacts on listed species

and critical habitat. Given that migratory, listed fish will use the structures regardless of their actual effectiveness, a failure to definitively determine their benefits will automatically result in a requirement to maintain the features for the full project life. NMFS will also consider the adverse effects of this monitoring on listed species, and will grant incidental take coverage as an amendment to this biological opinion, if warranted and necessary.

3. Mitigation work associated with Contract 42E must be completed or concurrently on-going with re-initiation of consultation for Contract 42F.

4. Construction sites for setback levees or other measures and removal of revetment are limited to the action area as described within this opinion.

6. Construction activities that must occur within the water, low flow channel, or within the area below the ordinary high water line shall be restricted to the period from **June 1 through October 30** of each construction year. Exceptions **may** be approved by NMFS upon review.

7. Stockpiling of construction materials, including portable equipment, vehicles and supplies, chemicals and petroleum products, shall be restricted to the designated construction staging areas and excluded from riparian and wetland avoidance areas.

8. Erosion control measures (best management practices) that prevent soil or sediment from entering the river shall be implemented, monitored for effectiveness, and maintained throughout the construction operations.

9. All litter, debris and unused materials, equipment or supplies shall be removed from below the ordinary high water line daily, and deposited at an appropriate site.

10. Any spills of hazardous materials within Sacramento River winter-run chinook salmon, Central Valley steelhead, and Central Valley spring-run chinook salmon habitat shall be cleaned up immediately and reported to the NMFS Sacramento office, phone 916/930-3600, within 24 hours. Such spills, and the success of the efforts to clean them up, shall be reported in post-construction compliance reports.

11. A Corps biologist shall be appointed by the Corps to be the contact for any employee or contractor who might incidentally take a living, or find a dead, injured, or entrapped Sacramento River winter-run chinook salmon, Central Valley steelhead, or Central Valley spring-run chinook salmon. This representative shall be identified to the employees and contractors during an employee education program conducted by the Corps on Sacramento River winter-run chinook salmon, Central Valley steelhead, and Central Valley spring-run chinook salmon.

12. If requested by NMFS, during or upon completion of construction activities, the Corps biologist shall accompany NMFS personnel for an on-site inspection of the sites to review project impacts.

13. All intakes for water pumps associated with wetting and/or irrigation of the project sites shall be screened to NMFS salmonid specifications. This does not apply to the agricultural diversion at RM 149.0 (see Conservation Recommendations).

14. A Corps biologist shall work closely with the contractor(s) through all construction stages to ensure that any living riparian vegetation or instream woody material within "vegetation clearing zones," which can reasonably be avoided without compromising basic engineering design and safety, is avoided and left undisturbed.

15. A vegetation monitoring and replacement program, reviewed and approved in advance by NMFS, and covering all areas where woody riparian vegetation would be replanted, shall be instituted following construction and carried out until it has been definitively assessed and *verified by NMFS* that the vegetation is self-sustaining.

16. Operations and Maintenance (O & M) requirements prepared by the Corps for each bank protection site shall contain measures to ensure the maintenance of the rock clusters and anchored LWD features in their finished or reasonably close to finished conditions for the full design life of the bank protection. Language providing such assurance(s) shall be provided to NMFS for review and concurrence before formal O & M documents are finalized by the Corps, and written evidence of acceptance of such assurance language by the local maintaining agency or district, shall be provided to NMFS.

17. A study of the efficacy of experimental minimization features–plantings in riprap, rock clusters, and anchored LWD–shall be instituted following construction. Focus of the study shall include (but not be limited to) LWD input and retention, sediment and organic matter retention and storage, habitat creation, and actual usage of the features by Sacramento River winter-run chinook salmon, Central Valley steelhead, and Central Valley spring-run chinook salmon and other fishes. *This study will continue until that time it has been verified by NMFS that RM 149.0 has been definitively assessed for all pertinent information as to value of the experimental design and benefit to listed salmonids.* Annual reports, and a final report deriving conclusions as to biological efficacy of the features, shall be provided to NMFS within 90 days of the study's conclusion.

The RPMs, with their implementing terms and conditions, are designed to minimize incidental take of Sacramento River winter-run chinook salmon, Central Valley steelhead and Central Valley spring-run chinook salmon that might otherwise result from the proposed action. If this minimized level of take should be exceeded within either the constructed features or the conservation measures, such new incidental take would represent new information requiring reconsideration of the RPMs provided here. At that time, the Corps must immediately provide an explanation of the causes of the taking and review with NMFS the need for possible modification of the RPMs.

E. Reporting Requirements

NMFS shall be notified immediately (less than 24 hours) via telephone and/or electronic mail, **and** in writing, if one or more salmon or steelhead are found dead or injured, and will review the activities resulting in take to determine if additional protective measures are required. Follow-up written notification shall include the date, time, and location of the carcass or injured specimen, a color photograph, cause of injury or death, and name and affiliation of the person who found the specimen. Any dead specimen should be placed in a cooler with ice and held for pickup by NMFS.

All requested reports shall be submitted to:

Supervisor
National Marine Fisheries Service
Sacramento Area Office
650 Capitol Mall, Suite 8-300
Sacramento, California 95814-4706
Ph. (916)930-3600
Fax.(916)930-3629

Any dead specimens of the Sacramento River winter-run chinook salmon, Central Valley steelhead, and Central Valley spring-run chinook salmon recovered should be preserved by freezing or placed in a container with 10 percent formalin solution. Information on time and exact location of taking, method of take, length of time from death to preservation, river temperature and flow conditions at the collection site, and any other relevant information should be recorded in writing and this record and the specimen(s) held for pickup by NMFS.

Within 60 days of completion of the proposed action, a compliance report shall be provided to the address above. This report shall describe dates of construction surveys and actual construction; implementation of project conservation measures, and the terms and conditions of the biological opinion; observed or other known effects on the Sacramento River winter-run chinook salmon, if any; and any occurrences of incidental take of the Sacramento River winter-run chinook salmon, Central Valley steelhead, and Central Valley spring-run chinook salmon.

X. CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the Act directs Federal agencies to utilize their authorities to further the purposes of the Act by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities that can be implemented to further the purposes of the Act, such as preservation of endangered species habitat, implementation of recovery actions, or development of information and data bases.

1. The Corps, under the authority of section 7(a)(1) of the Act, should implement recovery and Recovery Plan-based actions within and outside of traditional flood damage reduction projects.

2. The Corps should prepare a Supplemental EIS/EIR for the SRBPP that acknowledges the listing of five fish species since 1987 as significant and discloses to the public and resource agencies the detrimental, ecosystem-scale effects of riprapping, as described in Service (2000).

3. The Corps should preemptively implement biotechnical measures in place of traditional revetment techniques should any of the new reaches of riprap begin to cause scour and the need for additional bank stabilization at their up- or downstream ends. Hybrid biotechnical/geotechnical approaches, utilizing hard features with a significant bare-soil and vegetation component, should be applied to actively eroding sites in lieu of riprap.

4. The Corps should focus on retaining, restoring and creating river riparian corridors in the recovery of the listed salmonid species within their flood control plan. This change in focus could have an effect on future SRBPP consultations.

5 The Corps should facilitate the placement of an appropriately-designed fish screen on the irrigation diversion facility found at RM 149.0 to minimize take of listed fish possibly using the experimental habitat structure.

6. The Corps should make set-back levees integral components of the Corps' Sacramento and San Joaquin Basins Comprehensive Study and any other authorized bank protection or ecosystem restoration efforts.

7. The Corps should make more effective use of ecosystem restoration programs, such as those found in Sections 1135 and 206 of the respective Water Resource Developments Acts of 1986 and 1996. The Section 1135 program seems especially applicable as the depressed baselines of the Sacramento River winter-run chinook salmon, Central Valley steelhead, and Central Valley spring-run chinook salmon are, to an appreciable extent, the result of the Corps' SRBPP program.

8. The Corps should reduce application of PL 84-99 to repair sites not damaged by the 1997 floods and/or sites not identified as having critical needs for repair by the SRBPP. The PL 84-99 authority also should not be used to apply rock revetment to sites where only earthen banks existed previously or which suffer from design flaws not related to erosion.

9. The Corps should incorporate the costs of conducting lengthy planning efforts, involved consultations, implementation of proven offsite conservation measures, and maintenance and monitoring requirements associated with riprapping into each project's cost-benefit analysis such that the economic benefits of setback levees are more accurately expressed to the public and regulatory agencies. This includes a recognition of the economic value of salmonids as a commercial and sport fishing resource.

10. The Corps should conduct or fund studies to identify set-back levee opportunities, at locations where the existing levees are in need of repair or not, where set-back levees could be built now, under either the SRBPP, Comprehensive Study, or other appropriate Corps authority. Removal of the existing riprap from the abandoned levee should be investigated in restored sites and anywhere removal does not compromise flood safety.

11. The Corps should begin early intervention bank protection efforts with "softer" biotechnical approaches, which may then preclude later having to use rock fill and/or rock riprap to achieve engineering goals.

12. The Corps should conduct or fund studies to determine use by the Sacramento River winter-run chinook salmon, Central Valley steelhead, and Central Valley spring-run chinook salmon, if any, of various types of traditional and mitigation-feature-modified riprap, relative to the use of natural habitat, and provide such findings to NMFS.

13. As recommended in the NMFS Proposed Recovery Plan for the Sacramento River Winter-run Chinook Salmon, the Corps should preserve and restore riparian habitat and meander belts along the Sacramento River and the Sacramento-San Joaquin Delta with the following actions: (1) avoid any loss or additional fragmentation of riparian habitat in acreage, lineal coverage, or habitat value, and provide in-kind mitigation when such losses are unavoidable (e.g. create meander belts along the Sacramento River by levee setbacks); (2) assess riparian habitat along the Sacramento River from Keswick Dam to Chipps island and along Delta waterways within the rearing and migratory corridor of juvenile winter-run chinook salmon (3) develop and implement a Sacramento River and Delta Riparian Habitat Restoration and Management Plan (e.g. restore marshlands within the Delta and Suisun Bay); and (4) amend the Sacramento River Flood Control and Sacramento Bank Protection projects to recognize and ensure the protection of riparian habitat values for fish and wildlife (e.g. develop and implement alternative levee maintenance practices).

14. Section 404 authority should also be used more effectively to prevent the unauthorized application of riprap by private entities.

To be kept informed of actions minimizing or avoiding adverse effects, or benefitting listed and proposed species or their habitats, NMFS requests notification of the implementation of any conservation recommendations.

X. REINITIATION NOTICE

This concludes formal consultation on the Corps' Sacramento River Bank Protection Project between RM 0 and RM 194 on the lower Sacramento River.

As provided in 50 CFR 402.16, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been maintained (or is authorized by law) and if: (1) the amount or extent of incidental take is exceeded; (2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this opinion; (3) the agency action is subsequently modified in a manner that causes an effect to the listed species or critical habitat that was not considered in this opinion; or (4) a new species is listed or critical habitat designated that may be affected by the action. In instances where the amount or extent of incidental take is exceeded, formal consultation shall be reinitiated immediately.

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Appendix 1. Effects of Rip-Rapping on Salmonids and Components of Essential Fish Habitat.

Water Quality

Increased Temperature

Altered adult migration patterns, accelerated development of eggs and alevins, earlier fry emergence, increased metabolism, behavioral avoidance at high temperatures, increased primary and secondary production, increased susceptibility of both juveniles and adults to certain parasites and diseases, altered competitive interactions between species, mortality at sustained temperatures of >73-84F, reduced biodiversity.

Channel Structure

Flood Plains

Loss of overwintering habitat, loss of refuge from high flows, loss of inputs of organic matter and large wood, loss of sediment removal capacity.

Side-Channels

Loss of overwintering habitat, loss of refuge from high flows.

Pools and Riffles

Shift in the balance of species, loss of deep water cover and adult holding areas, reduced rearing sites for yearling and older juveniles.

Large Wood

Loss of cover from predators and high flows, reduced sediment and organic matter storage, reduced pool-forming structures, reduced organic substrate for macroinvertebrates, formation of new migration barriers, reduced capacity to trap salmon carcasses.

Substrate

Reduced survival of eggs and alevins, loss of inter-gravel spaces used for refuge by fry, reduced macroinvertebrate production, reduced biodiversity.

Hyporheic Zone (biologically active interface between groundwater area and stream bed)

Reduced exchange of nutrients between surface and subsurface waters and between aquatic and terrestrial ecosystems, reduced potential for recolonizing disturbed substrates.

Hydrology Discharge

Altered timing of discharge related life cycle cue (e.g., migrations), changes in availability of food organisms related to timing of emergence and recovery after disturbance, altered transport of sediment and fine particulate organic matter, reduced prey diversity.

Peak Flows

Scour-related mortality of eggs and alevins, reduced primary and secondary productivity, long-term depletion of large wood and organic matter, involuntary downstream movement of juveniles during high water flows, accelerated erosion of streambanks.

Low Flows

Crowding and increased competition for foraging sites, reduced primary and secondary productivity, increased vulnerability to predation, increased fine sediment deposition.

Rapid Fluctuations

Altered timing of discharge-related life cycle events (e.g., migrations), stranding, redd dewatering, intermittent connections between mainstream and floodplain rearing habitats, reduced primary and secondary productivity.

Riparian Forest Production of Large Wood

Loss of cover from predators and high flows, reduced sediment and organic matter storage, reduced pool-forming structures, reduced organic substrate for macroinvertebrates.

Production of Food Organisms and Organic Matter

Reduced production and abundance of certain macroinvertebrates, reduced surface-drifting food items, reduced growth in some seasons.

Shading

Increased water temperature, increased primary and secondary production, reduced overhead cover, altered foraging efficiency.

Vegetative Rooting Systems and Streambank Integrity

Loss of cover along channel margins, decreased channel stability, increased streambank erosion, increased landslides.

Nutrient Modification

Altered nutrient inputs from terrestrial ecosystems, altered primary and secondary production.

Attachment 1.

Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA)

ESSENTIAL FISH HABITAT CONSERVATION RECOMMENDATIONS[1]
Sacramento River Bank Protection Project Contracts 42E and 42F

I. IDENTIFICATION OF ESSENTIAL FISH HABITAT

The geographic extent of freshwater essential fish habitat (EFH) for the Pacific salmon fishery is proposed as waters currently or historically accessible to salmon within specific U.S. Geological Survey hydrologic units (Pacific Fisheries Management Council 1999). For the Sacramento River, the aquatic areas identified as EFH for chinook salmon are within the hydrologic unit map numbered 18020109 (Lower Sacramento River) and 18020112 (upper Sacramento River to Clear Creek). The upstream extent of Pacific salmon EFH in the Sacramento River is to Keswick Dam, at RM 302.

EFH is defined as those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity. For the purpose of interpreting the definition of essential fish habitat, "waters" include aquatic areas and their associated physical, chemical, and biological properties that are used by fish, and may include areas historically used by fish where appropriate; "substrate" includes sediment, hard bottom, structures underlying the waters, and associated biological communities; "necessary" means habitat required to support a sustainable fishery and a healthy ecosystem; and "spawning, breeding, feeding, or growth to maturity" covers a species' full life cycle.

The Central Valley river systems had historically supported the Central Valley fall/late fall-run chinook salmon (*Oncorhynchus tshawytscha*). Fall-run chinook salmon has always been widely distributed, while the late-fall chinook salmon were historically as well as currently low in abundance. The Sacramento, Feather, Yuba, American, Cosumnes, Mokelumne, Stanislaus, Tuolumne, Merced, and San Joaquin Rivers, and their tributaries continue to support wild remnants of the fall/late-fall chinook salmon ESU. Forty to fifty (40-50) percent of spawning and rearing habitats have been lost or degraded. Current distribution includes the mainstem Sacramento River and lower reaches of its tributaries, from upper Clear Creek on down, throughout the San Joaquin River, to the mouth of the confluence of San Francisco Bay (RM to RM). Fall/late-fall run (herein "fall-run") chinook salmon were once found throughout the Sacramento and San Joaquin River drainages, but have suffered declines since the mid-1900s as

[1]The 1996 amendments to the Magnuson-Stevens Fishery Conservation and Management Act (Magnuson-Stevens Act) set forth new mandates for the National Marine Fisheries Service (NMFS) and federal action agencies to protect important marine and anadromous fish habitat. Federal action agencies which fund, permit, or carry out activities that may adversely impact EFH are required to consult with NMFS regarding potential adverse effects of their actions on EFH, and respond in writing to NMFS "EFH Conservation Recommendations." The Pacific Fisheries Management Council has identified essential fish habitat (EFH) for the Pacific salmon fishery in Amendment 14 to the Pacific Coast Salmon Fishery Management Plan.

a result of several factors, including commercial fishing, blockage of spawning and rearing habitat, water flow fluctuations, unsuitable water temperatures, loss of fish in overflow basins, loss of genetic fitness and habitat competition due to straying hatchery fish, and a reduction in habitat quality.

All chinook salmon in the Sacramento/San Joaquin Basin are genetically and physically distinguishable from coastal forms (Clark 1929). In general, San Joaquin River populations tend to mature at an earlier age and spawn later in the year than Sacramento River populations. These differences could have been phenotypic responses to the generally warmer temperature and lower flow conditions found in the San Joaquin River Basin relative to the Sacramento River Basin. There is no apparent difference in the distribution of marine coded wire tag (CWT) recoveries from Sacramento and San Joaquin River hatchery populations, nor is there genetic differences between Sacramento and San Joaquin River fall-run populations (based on DNA and allozyme analysis) of a similar magnitude to that used in distinguishing other ESUs. This apparent lack of distinguishing life-history and genetic characteristics may be due, in part, to large-scale transfers of Sacramento River fall-run chinook salmon into the San Joaquin River Basin.

Central Valley fall-run chinook salmon are often caught in monitoring traps targeting winter-run and spring-run chinook salmon. However, despite diverse sources of information, there has been little effort at coordinating data to attain population assessments, and the viability of the wild fall-run population is currently unknown. Anadromous fish population levels are determined by many factors; however, increased runoff following the 1987-1992 drought, stricter ocean harvest regulations, and fisheries restoration actions throughout the Central Valley are thought to be the primary factors behind a general increase in salmon runs in the Sacramento River since 1990; this assumption is carried over to the wild fall-run chinook salmon population as well. Chinook salmon production is supplemented by fall and late-fall chinook salmon fish reared at the U.S. Fish and Wildlife-operated Coleman Fish Hatchery on the Sacramento River; and California Department of Fish and Game-operated Feather River Hatchery on the Feather River, Nimbus Hatchery on the American River, and Mokelumne Hatchery on the Mokelumne River (all fall-run chinook salmon). There are indications that fall-run populations are generally stable or increasing, but it is unclear if natural populations are self-sustaining because of high hatchery production. Concern remains over impacts from high hatchery production and harvest levels, although ocean and freshwater harvest rates have been recently reduced.

Life History and Habitat Requirements

Central Valley fall-run chinook are "ocean-type", entering the Sacramento and San Joaquin Rivers from July through April, and spawning from October through December. Peak spawning occurs in October and November (Reynolds et al. 1993). Chinook salmon spawning generally occurs in swift, relatively shallow riffles or along the edges of fast runs at depths greater than 6 inches, usually 1-3 feet to 10-15 feet. Preferred spawning substrate is clean loose gravel. Gravels are unsuitable for spawning when cemented with clay or fines, or when sediments settle out onto redds reducing intergravel percolation (NMFS 1997).

Egg incubation occurs from October through March, and juvenile rearing and smolt emigration occurs from January through June (Reynolds et al. 1993). Shortly after emergence from their gravel nests, most fry disperse downstream towards the Delta and estuary (Kjelson et al. 1982). The remainder of fry hide in the gravel or station in calm, shallow waters with bank cover such as tree roots, logs, and submerged or overhead vegetation. These juveniles feed and grow from January through mid-May, and emigrate to the Delta and estuary from mid-March through mid-June (Lister and Genoe 1970). As they grow, the juveniles associate with coarser substrates along the stream margin or farther from shore (Healey 1991). Along the emigration route, submerged and overhead cover in the form of rocks, submerged aquatic vegetation, logs, riparian vegetation, and undercut banks provide food, shade and protect juveniles and smolts from predation. These smolts generally spend a very short time in the Delta and estuary before entry into the ocean.

In contrast, the majority of fry carried downstream soon after emergence are believed to reside in the Delta and estuary for several months before entering the ocean (Healey 1980, 1982; Kjelson et al. 1982). Principal foods of chinook while rearing in freshwater and estuarine environments are larval and adult insects and zooplankton such as *Daphnia,* flys, gnats, mosquitoes or copepods (Kjelson et al. 1982), stonefly nymphs or beetle larvae (Chapman and Quistdorff 1938) as well as other estuarine and freshwater invertebrates. Whether entering the Delta or estuary as a fry or juvenile, fall-run chinook depend on passage through the Sacramento-San Joaquin Delta for access to the ocean.

The fish rear in calm, marginal areas of the river, particularly back eddies, behind fallen trees, near undercut tree roots or over areas of bank cover, and emigrate as smolts from April through June. Smolts are juvenile salmonids that are undergoing a physiological transformation that allows them to enter saltwater; they also lose their markings (parr marks) and appear silvery. They remain off the California coast during their ocean migration

Principal foods of chinook while rearing in freshwater and estuarine environments are larval and adult insects and zooplankton such as *Daphnia*, flys, gnats, mosquitoes or copepods (Kjelson et al. 1982), stonefly nymphs or beetle larvae (Chapman and Quistdorff 1938), as well as other estuarine and freshwater invertebrates.

II. PROPOSED ACTION

The proposed action is described in Part II of the preceding Biological Opinion for the endangered Sacramento River winter-run chinook salmon, threatened Central Valley steelhead, and Central Valley spring-run chinook salmon ESUs.

III. EFFECTS OF THE PROJECT ACTION

The Sacramento River still supports populations of Central Valley fall-run chinook salmon, primarily as rearing habitat and/or a migration corridor. As such, the availability of refugia in the form of "shaded riverine aquatic" (SRA) habitat is crucial to the survival and eventual recruitment of fall-run chinook populations. The proposed project at RM 149.0 will involve reducing 743 linear feet of natural embankment to 675 feet of uniform, hydraulically smooth riprap, and the removal of 0.26 acre of riparian trees. Adverse effects may include: degraded water quality (i.e. increased river turbidity and sedimentation; release of contaminants into the waterways); hampered juvenile feeding ability; delays in migration of juvenile or adult salmonids; and increased juvenile salmonid susceptibility to predation (Bisson and Bilby 1982; McLeay et al. 1984; Whitman et al. 1982). Release of contaminants could result in chronic or acute toxicity impacts to chinook salmon. Sensitive aquatic invertebrate prey populations may be adversely affected by degraded water quality.

The carrying capacity of the habitat will decrease with SRA removal and rip-rap modification of the embankment. Altered ecosystem features will adversely affect EFH and further degrade the environmental baseline of the fall-run chinook salmon (see Appendix 1). Restoring functional habitats depends largely on allowing natural processes to increase their ecological function, while at the same time removing adverse impacts of current practices.

The experimental design project for RM 149.0 is an environmental risk for salmonids, largely because it is unknown if and how the listed fish will utilize the project. Elements of structural complexity, woody material input, and riverine tree replacement have been incorporated into the design, which will be studied for its measure of success in providing habitat for salmonids.

The project action will be off-set by the implementation of a proven conservation measure(s), which presently include set-back levees, removal of riprap from and restoration of lands that currently lack lateral channel migration potential, including inter-levee terraces and potentially-eroding cut-banks. Temporal delays will be incorporated into the measure(s) through escalating compensation ratios, ultimately resulting in no net loss and replacement-in-kind of habitat.

IV. CONCLUSION

Upon review of the effects of the Sacramento River Bank Protection Projects Contracts 42E and 42F, NMFS believes that the construction and temporal effects of the experimental design at RM 149.0 will initially result in adverse modifications to the EFH of fall and late-fall run chinook salmon. However, it is NMFS' opinion that the adverse effects caused by the implementation of the experimental design at RM 149.0 will be temporary, and ultimately compensated by an improved environmental baseline for the fall/late-fall run chinook salmon, aiding in their recovery process with the incorporation of mitigation. It is also believed that the data collected from the experimental design at RM 149.0 will provide some direction in assessing the true replacement value of a "technical fix" with the dual purpose of flood protection and provision of refugia for fish critically dependent upon EFH availability.

V. EFH CONSERVATION RECOMMENDATIONS

NMFS recommends that Reasonable and Prudent Measures Numbers 1, 2, 3, and 4, and their respective Terms and Conditions listed in the Incidental Take Statement prepared for the Sacramento River winter-run chinook salmon, Central Valley steelhead, and Central Valley spring-run chinook salmon ESUs in the preceding Biological Opinion, be adopted as EFH Conservation Recommendations. In addition, additional EFH Conservation Recommendations are provided below. These recommendations are provided as advisory measures.

Bank Stabilization

1. The Corps and Reclamation Board should ensure that NMFS receives copies of all fishery monitoring reports, in addition to reports required under the Terms and Conditions of the preceding Sacramento River Bank Protection Project - Contracts 42E and 42F Biological Opinion.

2. Setback levees and vegetative methods of bank erosion control should be used whenever feasible. Where vegetative mechanisms are not sufficient alone, explore these methods in conjunction with ground contouring. Hard bank protection should be a **last** resort and the following options should be explored, in order of priority: tree revetments, stream barbs/flow deflectors, toe-rock and vegetative rip-rap.

3. Contour slopes according to the preferred ratio of 3-5:1 and avoid slopes of less than 2:1.

4. Develop plans that minimize alteration or disturbance of the bank and existing riparian vegetation. Use temporary fencing to minimize disturbance from intrusion.

5. Revegetate sites to resemble the appropriate natural community associations, utilizing vegetation management to limit livestock grazing and maintain an appropriate buffer zone.

Woody Debris Removal

1. Avoid removing wood debris and large rocks and boulders in salmon EFH.

2. Educate landowners and boaters about the benefits of maintaining large woody debris in streams to enhance properly functioning salmon habitat conditions.

VI. U.S. ARMY CORPS OF ENGINEERS STATUTORY REQUIREMENTS

Section 305(b)(4)(B) of the Magnuson-Stevens Act and Federal regulations (50 CFR § 600.920) to implement the EFH provisions of the Magnuson-Stevens Act require federal action agencies to provide a detailed written response to NMFS, within 30 days of its receipt, responding to the EFH Conservation Recommendations. The response must include a description of measures adopted by the Corps for avoiding, mitigating, or offsetting the impact of the project on Pacific salmon EFH. In the case of a response that is inconsistent with NMFS' recommendations, the

Corps must explain its reasons for not following the recommendations, including the scientific justification for any disagreements with NMFS over the anticipated effects of the proposed action and the measures needed to avoid, minimize, mitigate, or offset such effects (50 CFR 600.920(j)).

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